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SIR WILLIAM HENRY BRAGG, O.M., F.R.S.

BRITISH Science loses one of its most distinguished leaders in the death of Sir W. H. Bragg "full of years and of honours" on the 12th of March 1942. Born in Great Britain and educated in the Isle of Man and at the Cambridge University, he went to Australia as Professor at the University of Adelaide in 1885 and by his work there won his election to the Fellowship of the Royal Society in 1906. He returned to Great Britain in 1909 as Professor at the Leeds University, moving to the University College, London as Quain Professor in 1915. He resigned this chair in 1923 to take up the Directorship at the Royal Institution, a position which he continued to hold till his death at the age of nearly 80 years.

There are many interesting references to Sir William Bragg and extracts from the correspondence which passed between him and Lord Rutherford in Eve's biography of the latter. These throw a vivid light on the scientific interests of both men and their influence on each other. The earliest reference dates to the year 1895 when Rutherford visited Bragg at Adelaide while on his way from New Zealand to Cambridge to join as a research student under J. J. Thomson! Thus, in a sentence, are linked the names of a trio who symbolised British physics in the first three decades of the twentieth century, just as the trio Kelvin, Stokes and Rayleigh symbolised it in the last three decades of the nineteenth century. One has only to recall the names of these men and their achievements to realise the tremendously rapid development of physics during this epoch and to appreciate their share in creating the objective or experimental basis on which the structure of physics rests at the present time.

The enormous interest excited by the discovery of radio-activity and by the early

investigations of the Curies and of Rutherford appears to have been responsible for galvanising the Adelaide Professor into a career of research activity. Indeed, till 1912, the scientific interests of Bragg appear to have centred largely on radioactivity and the ionising radiations produced by it. The earliest published paper by Bragg to which I have been able to find a reference appeared in the *Philosophical Magazine* for December 1904 and deals with this subject. Both success and recognition came to him very quickly. His principal discovery was the recognition that alpha particles from radium and its subsequent products had definite but different ranges in air. A little later, he also made the discovery that when gamma rays from radium struck a thin plate of metal, the radiation forwards were greater than the back radiations. This surprising observation led him to put forward the view that both gamma rays and X-rays were corpuscular in nature. In fact, Bragg became a strong advocate of the idea that X-rays were neutral doublets made up of both kinds of electricity. This opinion was contested by J. J. Thomson and by C. G. Barkla who put forward evidence supporting the view that X-rays were in the nature of electrical waves.

The epoch-making discovery of the diffraction of X-rays in crystals made in 1912 by Laue had the effect, not only of convincing Bragg of the error of his views regarding the nature of X-rays, but also of setting his feet on the path of research which earned for him the award of the Nobel Prize for Physics in 1915 jointly with his son W. L. Bragg. In the special number of *Current Science* entitled "Laue Diagrams" published in 1937, the story of Laue's great discovery and of its subsequent developments has been told in full by the leading authorities on the subject. It is therefore unnecessary here to recapitulate this well-known chapter of modern scientific history. The recognition of the importance of the work of the Braggs in this field was to no small extent aided by the publication of their joint work entitled "X-rays and Crystal Structure" which appeared in 1915 and went through several editions. A smaller book entitled "An Introduction to Crystal Analysis" by W. H. Bragg published in 1928 was also a useful treatise of a more popular kind.

The high position that Sir William Bragg occupied both in the esteem of scientific men and in the public eye was, I believe, to no small extent based on an appreciation of his remarkable gifts for popular exposition of scientific topics, derived no doubt from his long experience as a teacher. The Royal Institution offered him a splendid forum for the exercise of these gifts. The subsequent publication of these lectures in a series of charmingly produced and illustrated volumes made them accessible to a world-wide audience. "The World of Sound", "Concerning the Nature of Things", "Old Trades and New Knowledge" and "The Universe of Light", are a series of books which will continue to delight both young and old for many years.

My first personal contact with Sir William Bragg was in the summer of 1921 when I visited him at his laboratory at the University College in London. He showed me a model of the naphthalene crystal on which he was then at work and which he made the subject of his Presidential Address to the Physical Society later in the same year. I next saw him when I was in London in the summer of 1924 prior

to the visit of the British Association to Canada in that year. Bragg was then at the Royal Institution, still greatly interested in his organic crystals. He had Muller, Shearer and others with him hard at work preparing the long-chain aliphatic compounds and studying their structure. Bragg seemed to be much happier in the atmosphere of the Royal Institution than at the University College. Possibly he had had enough of University teaching and examinations after doing them for nearly forty years! Bragg presided at my lecture on the Scattering of Light to the British Association at Toronto. We were in the same train together travelling across Canada to Victoria and back. My contacts with Bragg on my subsequent visits to London in 1929 and 1930 were very brief.

Sir William's laboratory at the Royal Institution has been for many years a place of pilgrimage to X-ray workers from all the world over. My own personal impression derived from such contacts as I had was that Sir William was a very unselfish and loveable personality, anxious to help others forward in their work. He had, of course, his limitations, one of which was, I think, an insufficient appreciation of the newer viewpoints in theoretical physics. But this was not surprising, seeing that he belonged quite as much to the nineteenth century as to the twentieth.

Like "J. J." and Rutherford, he lived to achieve the highest honours which a British man of science could hope to achieve in his own country, namely the Copley Medal, the Presidentship of the Royal Society and the Order of Merit. Curiously enough, his Knighthood was, I believe, given not for his work on X-rays, but for his studies on sound-ranging in the last war!

C. V. RAMAN.

THE NUTRITION SOCIETY

A NEW scientific society, the Nutrition Society, has been inaugurated in England by Professor F. G. Hopkins, with Cambridge as its Headquarters. Sir John Orr, who is one of the few to realize the importance of Nutrition in relation of national efficiency, is the first Chairman of the Society.

Work on Nutrition is, in fact, being carried on from different angles by medical practitioners, biochemists and physiologists, agriculturists and veterinarians, dietitians and sociologists, economists, statistitians, food technologists and administrators. The new Society will provide a common meeting-ground for the discussion of all aspects of Nutrition, formerly partitioned by barriers of specialisation.

In this country, problems of nutrition are being studied principally at Coonoor under the direction of Dr. W. R. Aykroyd. There are also a few centres of research, where work of a basic character is being done. Several of the Provincial and State Governments have carried out dietary and economic surveys in their respective provinces. For now more than a decade, Rao Bahadur B. Viswanath, since his discovery that farm-yard manure raises crops with richer content of vitamins, has been advocating a closer collaboration between the science of agriculture and the science of nutrition. The Indian Research Fund Association and the Lady Tata Trust, among others, have encouraged research in the field of Nutrition in this country, by financing schemes of research in this subject.

So far as we are aware there does not appear to be any Central Organisation, which could correlate and organise these research activities and utilise the results in building up a healthy and virile nation. Does not the present afford an opportune moment to organise a society on lines similar to those adopted by the Nutrition Society of England?

EMIL FISCHER'S WORK ON THE CHEMISTRY OF HEXOSES

BY

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THIS is a very brief note on Emil Fischer's work on the hexoses; it is just 50 years ago that Emil Fischer published his first paper on the structure of hexoses.

Upto the year 1880, our knowledge of the sugar group was very meagre and consisted of a chaos of isolated facts. Zincke (1876) assigned the ketonic structure to glucose (CH_2OH-CHOH-CHOH-CHOH-CO-CH_2OH) and fructose (CH_2OH-CHOH-CHOH-CO-CHOH-CH_2OH), but Kiliani (1886) corrected this view by the application of cyanohydrin reaction and represented these compounds thus: Glucose—C^6H_2OH-C^5HOH-C^4HOH-C^3HOH-C^2HOH-C^1HO, Fructose—CH_2OH-CHOH-CHOH-CHOH-CO-CH_2OH. Kiliani was also responsible for showing arabinose to be a pentose (1886) and galactose (1885) to be a straight chain pentahydroxyaldehyde, isomeric with glucose. But Kiliani's success was short lived: he could not follow it up in view of the almost insurmountable experimental difficulties; sugars crystallise with difficulty even when pure; when other substances are present, the task of isolating a sugar from the mixture is hopeless. Such was in brief the state of sugar chemistry when Emil Fischer started his researches on hexoses in 1887, and brought them to a successful conclusion within less than a decade. There were three factors which contributed to the remarkable achievements of Fischer in this extremely difficult field of work. Firstly he possessed in himself rare skill, patience and insight which are seldom combined in one individual. The second factor which ensured his success was the doctrine of the asymmetric carbon atom propounded by Van't Hoff and Le Bel in 1874. Fischer made it the theoretical basis and the guiding principle in these astonishingly successful researches which in turn vindicated the truth of the new doctrine of molecular configuration. The third factor which assisted this experimental skill and theoretical insight was his discovery of phenylhydrazine in 1875. This substance acted as a magician's wand in Fischer's hands. Fischer found that hexoses first react with one molecule of phenylhydrazine to give a phenylhydrazone which is usually soluble and escapes detection, but with an excess of the base (2 molecules), the hydrozone is converted into an osazone: C^6H_2OH-C^5HOH-C^4HOH-C^3HOH-C^2-$C^1H = N$-NHC_6H_5. The

$$C_6H_5\text{-}HN\text{-}N$$

osazones, being insoluble in water and easily crystallisable from organic solvents, were thus found by Fischer to be very suitable for detecting and identifying sugars by their melting points. Fischer (1887) further found that several sugars give identical osazones, namely, glucose, mannose, and fructose give one and the same derivative (glucosazone). The osazones on hydrolysis and subsequent reduction yield ketoses. The Kiliani structural formula of glucose contains 4 asymmetric carbon atoms, numbered 2, 3, 4 and 5 and this formula according to Van't Hoff and Le Bel theory, should exist in 16 optically active forms in 8 opposite pairs. Sugars producing the same osazone thus had identical structure on all but the first two carbon atoms, numbered 1 and 2.

Another even more important application of osazones was in the complete synthesis of glucose, fructose and mannose in their enantiomorphous forms. Starting from α-acrose (*dl.* fructose) which he had obtained separately from formaldehyde, acrolein dibromide and glycerose, Fischer was able to achieve the synthesis of the above-mentioned sugars by a series of difficult operations, which consisted in resolving the sugars and the corresponding acids into their enantiomorphous forms by Pasteur's methods, reducing the sugar acids (lactones) into the corresponding sugars in acid solution, transforming a sugar acid into

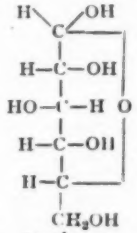
an isomeric one by heating it at 140° C. with pyridine or quinoline by means of an epimeric change, in which the configuration of the carbon atom adjacent to the carboxyl group becomes inverted. This enabled Fischer (1889 and 1890) to produce *l*-glucose, *d*-talose, and *d*-idose through *l*-mannonic, *d*-galactonic, and *d*-gulonic acids respectively.

No less than 16 isomeric aldohexoses are possible which possess the structural formula of a straight chain pentahydroxyaldehyde, CH_2OH-CHOH-CHOH-CHOH-CHOH-CHO. The principles which Fischer employed in elucidating the space configurations of the hexoses were dependent on the identity of the osazones of the different sugars, the oxidation of sugars to *meso* acids or reduction to *meso* alcohols, methods for building up or degrading sugars and transformations of sugar acids into their isomers by epimeric changes. Thus the projection formulæ of glucose, mannose and fructose obtained in this way are given below by way of illustration:

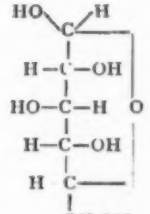
1	..	CHO	CHO	CH_2OH
2	..	H—C—OH	HO—C—H	CO
3	..	HO—C—H	HO—C—H	HO—C—H
4	..	H—C—OH	H—C—OH	H—C—OH
5	...	H—C—OH	H—C—OH	H—C—OH
6	..	CH OH	CH_2OH	CH_2OH
		d-glucose	*d*-mannose	*d*-fructose

By the application of these methods and reasonings, Fischer synthesised and configurated twelve out of the sixteen theoretically possible aldohexoses, and since then the remaining two pairs (allose and altrose) have been configurated by Levene and Jacobs (1910).

This account of the chemistry of hexoses, illustrating as it does a remarkable combination of theory and practice, will be incomplete without reference to another advance which has proved highly fruitful in the whole domain of carbohydrates. In the foregoing account the aldehyde structure of the sugars has been assumed. That sugars and their derivatives possess oxide ring structures was established by unequivocal evidence. From an assumed analogy with γ-lactones, Fischer assigned the butylene or 1 : 4 oxide ring to α- and β-methyl-glucosides and the parent sugars, but this structure was subsequently corrected by the work of Haworth (1925) which gives the pyranose formulation:



α-glucose,
$[\alpha]_D$ 110° → 52·5°



β-glucose,
$[\alpha]_D$ 17·5° → 52·5°

His discovery of γ-methyl-glucoside in 1914 led to the recognition of a different cyclic structure from that given in the foregoing formulation and laid the foundation of work associated with Purdie and the St. Andrews School. Just as phenylhydrazine had proved a valuable weapon in the hands of Fischer, this new development was made possible by the discovery of another weapon in the 'methylation process', and led to the recognition of five different oxide rings for *d*-glucose, giving ten isomerides of *d*-glucose, excluding the aldehyde form.

The evolution of a single straight chain pentahydroxyaldehyde formula into 16 optically active configurations and their subsequent possible expansion into 160 isomeric formulæ, having five different oxide ring structures, furnishes a most remarkable development of molecular structure and molecular configuration, based on the theoretical speculations of Kekule, Van't Hoff and Le Bel.

There is thus no doubt that this later development by Fischer will continue to inspire the prosecution of research in this field by several generations of chemists.

ON LATIN AND HYPER-GRAECO-LATIN CUBES AND HYPER-CUBES

BY

K. KISHEN

(Agricultural College, Cawnpore)

LATIN and Hyper-Graeco-Latin squares were first introduced by Euler[1] in 1782 and have since been extensively studied by a number of mathematicians like Gunther,[2] Cayley,[3] Maillet,[4] Coccoz,[5] Akar,[6] Brocard,[7] Tarry,[8,9,10] Macmahon,[11] MacNeish,[12] Margossian,[13,14] Fisher and Yates,[15,16] Fisher,[17] Bose,[18] Stevens[19] and Norton.[20] To Fisher is due the credit of pointing out their uses in the design of experiments; and with the realisation of their fundamental importance in the theory of this branch of statistics, much attention has been devoted to their study by statisticians in recent years.

2. Fisher introduced the idea of confounding of interactions in symmetrical factorial arrangements, which was extended by Yates to agronomic tests, involving a number of varieties equal to a prime positive integer or a power of prime, in order to increase the 'efficiency' (or accuracy) of the experiments. But it is no disparagement of their work to say that there is a lack of a unified general solution. Nair's work,[21,22] done subsequent to this, was an advance over our then existing knowledge of factorial arrangements in that he developed a method of constructing confounded arrangements in an s^m design, (s a prime positive integer or a power of a prime) in s^2-plot blocks, based on his theory of interchanges derivable from the associated Hyper-Graeco-Latin squares.

But a more complete solution in the case of the general symmetrical factorial arrangement was given by Bose and Kishen,[23] whose investigations achieved the unification and systematization which were lacking in previous work on the subject. Besides succeeding in giving a general method for the formation of confounded arrangements in an s^m design in blocks of s^{m-k} plots and the identification of the confounded degrees of freedom, the authors were able to enunciate the important principle of generalized interaction which enables the best sets of treatment comparisons which may profitably be confounded in any given case to be set down easily and elegantly. It is hoped that the concept of Latin and completely orthogonalized Hyper-Graeco-Latin cubes and hyper-cubes which is now being introduced may be helpful for a fuller understanding of the theory of the general symmetrical factorial arrangement.

3. A Latin cube of the *first order* of side s may be defined as a cube arrangement of s^3 letters, s^2 of each of s kinds, such that each letter occurs exactly s times in each of its three sets of s planes, parallel to the three co-ordinate planes OX_1X_2, OX_1X_3 and OX_2X_3. A Latin cube of the *second order* of side s may be defined as a cube arrangement of s^3 letters, s of each of s^2 kinds, such that each letter occurs exactly once in each of its three sets of s planes parallel to the co-ordinate planes. Thus for $s = 3$, Latin cubes of the first and second orders may be diagrammatically represented as under in Figs. 1 and 2 respectively.

4. If an s-sided Latin cube of the *first order* is superimposed on another s-sided Latin cube of the *first order* such that every letter of one cube occurs exactly s times with every letter of the other cube, the two Latin cubes may be said to be orthogonal to each other. When the letters of the first

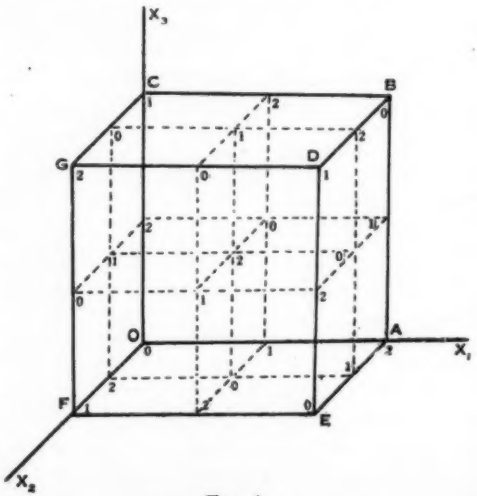


FIG. 1

2×2×2. Latin Cube of First Order

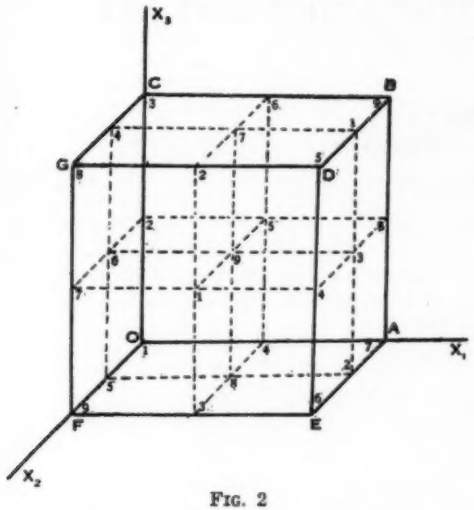


FIG. 2

2×2×2. Latin Cube of Second Order

cube are denoted by Latin letters and those of the second cube by Greek letters, and the second is superimposed on the first, the two together may be said to constitute a Graeco-Latin cube of the *first order*. The number of Latin cubes of the first order constituting a completely orthogonalized Hyper-Graeco-Latin cube of the first order has been found to be $s^2 + s - 2$.

5. In general, we may define an s-sided m-fold Latin hyper-cube of the *r-th order* as an m-fold hyper-cube arrangement of s^m letters, s^{m-r} of each of s^r kinds, such that each letter occurs exactly s^{m-r-1} times in each of its m sets of s $(m-1)$-flats, parallel to the m co-ordinate $(m-1)$-flats $OX_1X_2\cdots X_{m-1}$, $OX_1X_2\cdots X_{m-2}X_m, \cdots$ $OX_1X_2\cdots X_{i-1}X_{i+1}\cdots X_m, \cdots OX_2X_3\cdots X_m$. Two such Latin hyper-cubes, one superimposed on the other, such that every letter of the one occurs exactly s^{m-2r} times with every letter of the other, may be said to be orthogonal to each other. Denoting, as before, letters of the first hyper-cube by Latin letters and those of the second hyper-cube by Greek letters, the composite hyper-cube may be said to constitute an m-fold Graeco-Latin hyper-cube of the *r-th order* and it is obvious that the highest possible value for r is $\frac{m-1}{2}$, when m is odd, and is $\frac{m}{2}$, when m is even.

6. I have been able to establish that Latin cubes and hyper-cubes of the first order of any side exist and that s-sided m-fold Latin hyper-cubes of the rth order [$r \leqq (m-1)$, the sign of equality not holding in certain cases] also exist, s being a prime positive integer or a power of a prime. I have also been able to demonstrate that the existence of an s-sided m-fold Hyper-Graeco-Latin hyper-cube of the *first order* is exactly equivalent to the existence of the finite hyper-dimensional projective geometry $PG(m, s)$, whence it follows that the total number of m-fold Latin hyper-cubes of the *first order* constituting an s-sided m-fold completely orthogonalized Hyper-Graeco-Latin-hyper-cube of the *first order* is $s^{m-1} + s^{m-2} + \cdots\cdots + s^2 + s - (m-1)$. For full details the interested reader is referred to the author's paper on the subject to be published shortly elsewhere.

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LETTERS TO THE EDITOR

CRYSTAL ORIENTATION AND THE RAMAN SPECTRUM OF CALCITE

Nedungadi[1] and Bhagavantam[2] studied the effect of crystal orientation on the Raman spectra of sodium nitrate and calcite respectively. It has been observed in both the cases that the low frequency lines are very weak while the line due to the total symmetric oscillation comes out quite strongly when the incident light vector lies in the plane of the nitrate or the carbonate ion and the scattered light is along the optic axis. The reverse is the case when the incident light vector is parallel to the optic axis and the direction of the scattered light lies in the plane of the nitrate or carbonate ion. The above observation clearly indicates that the various tensor components, especially in the case of the total symmetric oscillation, are unequal among themselves as $a_{xx} = a_{yy} \neq a_{zz}$. Bhagavantam has postulated that in the case of the 1085 line in calcite, a_{xx} and a_{yy} are each about three times as large as a_{zz}. Intensities involving a_{xx} or a_{yy} will correspondingly be about ten times as large as those containing a_{zz}.

The author has obtained the Raman spectra of a well polished one-inch cube of calcite, cut in such a manner that its optic axis is parallel to one of the edges, for both the above-mentioned orientations on the same photographic plate. Great care has been taken to see that the time of exposure and the intensity of the source remained the same while photographing the two spectra. A set of intensity marks obtained by the method of varying slit widths is recorded on the same plate and the relative intensities are obtained from the density-log intensity curves in the usual manner. The ratio of the intensities of the 1085 line, in the two cases, is obtained as 7·94 for the 4358 excitation and 7·38 for the 4047 excitation. Hence, it may be concluded that the corresponding tensor components are related as $a_{xx} = a_{yy} = 2 \cdot 8\ a_{zz}$.

The author desires to express his grateful thanks to Prof. S. Bhagavantam for his keen interest in this work.

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Andhra University,
Waltair,
February 18, 1942.

[1] Nedungadi, *Proc. Ind. Acad. Sci.*, 1939, **10**, 197.
[2] Bhagavantam, *Ibid.*, 1940, **11**, 62.

RAMAN SPECTRA OF IODIC ACID AT DIFFERENT DILUTIONS

FROM a study of the variation with concentration of physico-chemical properties, such as density, viscosity, surface tension parachor, refractive index, magnetic susceptibility, etc., M. R. Nayar and co-workers[1] have found breaks in the various curves at definite concentrations, namely, 0·09 N and 0·04 N. According to them a concentrated solution contains mainly trimeric molecules $(HIO_3)_3$, which gradually change into dimers $(HIO_3)_2$ and then into monomers and simple ions as dilution increases. The course of depolymerisation of the trimeric molecules of the acid has been pictured as:

$$\tfrac{1}{3}(HIO_3)_3 \xrightarrow[0\cdot09\ N]{} \tfrac{1}{2}(HIO_3)_2 \xrightarrow[0\cdot04\ N]{} HIO_3 \rightarrow H^+ + IO_3^-$$

the last one refers to potassium iodate. It is evident that the Raman spectra of the acid solutions are not changed very much down to a concentration of about 0·2 N. The most intense line 789 in band III, however, disappears at this dilution, while the line 804 previously of medium intensity now becomes the most prominent. The less prominent lines constituting bands I and II have all disappeared.

In 0·07 N solution a line 812 makes its appearance for the first time, which persists with further dilution, while all other lines disappear. This line which is the only one present in 0·03 N solution is given also by KIO_3 solution (0·2 N). This frequency may reasonably be attributed to free IO_3 ions, while the rest must be partly ascribed to polymers of the acid, and partly to modification of the IO_3 frequency due to co-ordination.

Concn.	Band I			Band II			Band III		
4·5 N ..	317(7)*,	332(7),	354(6),	449(1),	642(4),	653(3),	789(10)	806(8)	826(6)
1·0 N ..	318(4)	..	..	..	641(3),	654(2),	785(10)	807(9)	824(7)
0·2 N ..	..	..	..	..	..	..	..	804(5)	824(3)
0·07 N ..	..	..	..	..	..	..	..	804(5), 812(4)	828(2)
0·03 N ..	..	..	..	..	..	..	..	811	..
0·2 N (KIO_3)	..	..	..	..	..	..	..	811	..

* The numbers within brackets refer to intensity estimated visually.

The breaks in the curves are attributed to transitions from one kind of molecule to another.

The fact that a solution of iodic acid yields different Raman spectra at different concentrations was first pointed out by Nayar and Sharma,[2] and subsequently confirmed by Venkateswaran.[3] In the present investigation Raman spectra of the acid solution have been obtained for concentrations ranging on either side of the transition points. Microphotometric records of all the plates were also obtained and the frequencies (wave numbers) were recorded (see table above).

The first five results refer to iodic acid, while

The results in any case are in conformity with the physico-chemical observations already referred to. The detailed paper will be published elsewhere.

J. RAO SARAF.

Physics Department,
Lucknow University,
February 20, 1942.

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PHOTOCHEMICAL ANALYSIS

SEVERAL methods[1] have been proposed for the estimation of mercuric chloride, but they are not satisfactory either on account of (1) cumbursomeness, involving considerable time, etc., or (2) lack of sufficient accuracy or (3) the use of costly reagents. In our method we made use of the photochemical reaction between mercuric chloride and potassium oxalate in aqueous solution. At laboratory temperatures, in the dark, there is no appreciable reaction, but on exposure to light of suitable wave-length there is copious precipitation of mercurous chloride. Working with Monax or Pyrex glass conical flasks in sunlight, we found that the reaction goes to quantitative completion in about 30 to 60 minutes, in the presence of a minute concentration of uranyl nitrate, which acts as the photosensitizer. After exposure to light for the requisite time, the mixture is treated without filtration with a known excess of standard solution of iodine in potassium iodide. The precipitated mercurous chloride dissolves readily according to the following reaction

$$Hg_2Cl_2 + 6\ KI + I_2 \rightarrow 2\ K_2\ Hg\ I_4 + 2\ KCl.$$

After adding the iodine solution, the flask is stoppered and allowed to stand for a few minutes with occasional agitation, until complete solution takes place. The residual iodine is titrated with standard sodium thiosulphate solution with starch as the indicator. From the volume of the standard iodine solution consumed in the oxidation of the mercurous to mercuric ion, we can calculate the amount of mercurous chloride formed in the photochemical reaction, and hence that of the mercuric chloride originally taken.

In the absence of the uranyl nitrate, the reaction takes place only very slowly. The uranyl nitrate does not interfere with the reaction or with the iodometric estimation in any manner, under the conditions described. The following table embodies typical results.

X ml. of M/20 $HgCl_2$ + X ml. of M/5 sodium oxalate + $\frac{X}{5}$ ml. of M/50 uranyl nitrate solution, exposed to bright sunlight for 45 minutes.

Volume of $HgCl_2$ solution (x)	Milligrams of Hg taken	Milligrams of Hg found	Error per cent.
15 ml.	150·45	150·14	0·2
10 ml.	100·30	100·00	0·3
5 ml.	50·15	50·03	0·24
2 ml.	20·06	19·15	0·55
1 ml.	10·03	9·09	0·40

If the exposure to light is unduly prolonged, the mercurous chloride formed tends to decompose further into mercury. The appearance of a slight incipient grey colour is an indication that the reaction is complete. While working with concentrations of mercury chloride lower than M/100, the concentration of oxalate should be reduced, as otherwise the mercurous chloride undergoes further decomposition to metallic mercury. The uranyl nitrate concentration is however, retained at the usual value. Working with M/200 solution of mercuric chloride, we used M/50 solution of sodium oxalate with good results. We found that even one milligram of mercury in the form of mercuric chloride can be estimated with ease and considerable accuracy.

G. GOPALARAO.
P. T. RAMACHARLU.

Andhra University,
Waltair,
December 18, 1941.

[1] (*a*) Rupp and Müller, *Z. anal. Chem.*, 1925, **67**, 20; *Analyst*, 1925, **50**, 579.

(*b*) Hillebrand and Lundell, *Applied Inorganic Analysis*, 1929, 172 (John Wiley & Son), 1929.

(*c*) Moser and Niessner, *Z. anal. Chem.*, 1928, **74**, 200.

(*d*) Robinson, *Analyst*, 1929, **52**, 146.

CATALYSIS OF DICHROMATE-HYDRIODIC ACID REACTION BY THE OXALATE ION

THE use of potassium dichromate as a primary standard in iodimetry is based on the following reaction.

$$Cr_2O_7^{--} + 14H^+ + 6I^- \rightarrow 3I_2 + 2\ Cr^{+++} + 7H_2O$$

The main features of this reaction are (1) increase in the speed of the reaction with increase in the concentration of iodide, dichromate and H^+ ion, and (2) the interference of the autoxidation of hydriodic acid by atmospheric oxygen, which becomes appreciable at high concentrations of acid and of iodide, and in the presence of light. In spite of suitable precautions taken to overcome the difficulties encountered, the titration of weak solutions of dichromate (0·01 to 0·001 N) gives uncertain results. I. M. Kolthoff[1] has endeavoured to find suitable positive catalysts for this reaction, in order to improve the method, but without success. During the course of some other work, we accidentally discovered that oxalate ion exerts a marked catalytic effect on the reaction between dichromate and hydriodic acid. As this result is of great analytical and theoretical significance, we investigated the phenomenon in some detail.

The following table embodies some typical results.

5 ml of 0·001 N $K_2Cr_2O_7$ solution + 1 ml of 2 N HCl + 1 ml of O·5 N KI + 2 ml of 1 per cent. starch + oxalate solution + distilled water, to make up to 20 ml.

Concentration of oxalate	Amount of iodine liberated in ml hypo solution instantaneously	Amount of iodine liberated in ml hypo solution in two minutes	Amount of iodine in ml hypo solution theoretical
Nil	3·77	4·56	5·40
0·000125 N	5·29	5·30	5·40
0·000250 N	5·30	5·36	5·40
0·000500 N	5·32	5·38	5·40
0·002500 N	5·37	5·38	5·40
0·010000 N	5·35	5·38	5·40

It will be seen from the above table that less than the theoretical quantity of iodine is liberated in the absence of oxalate, even when two minutes were allowed for the reaction. If an instantaneous titration is desired, Kolthoff recommends at least 20 ml of 4 N HCl per 100 ml of the reaction mixture. But it is the general concensus of opinion (*cf.* W. C. Vosburgh[2]) that at this high acid concentration the error due to air oxidation of hydriodic acid becomes appreciable.

From our results it is also evident that with a suitable concentration of oxalate, the quantitative liberation of iodine takes place almost instantaneously even at low hydrogen ion concentration, enabling the titration to be finished quickly. Control experiments have shown that, under our conditions, the reaction between oxalate and iodine and the reaction between oxalate and chromic acid do not interfere.

Oxalates of potassium, sodium and ammonium have been studied with almost identical results, so that we can conclude that it is the oxalate ion that exerts the catalytic effect. We also found that citrate and tartrate ions exert a positive catalytic influence, though to a lower degree than the oxalate ion. Succinate has no effect.

Fuller details will be published elsewhere.

C. R. Viswanadham.
G. Gopalarao.

Andhra University,
Waltair,
December 18, 1941.

[1] I. M. Kolthoff, *Z. anal. Chem*, 1920 **59**, 4041; *Volumetric Analysis*, 1929, 369 (John Wiley and Son).

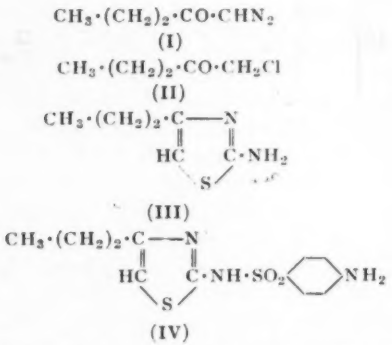
[2] W. C. Vosburgh, *J. Amer. Chem. Soc.*, 1922, **4**, 2120.

2-N¹-SULPHANILAMIDO-4-*n*-PROPYLTHIAZOLE

In a recent publication,[1] we have described the synthesis of a series of 5-alkyl derivatives of 2-sulphanilamidothiazole. As a sequel to this, we undertook to synthesise a series of 4-alkyl derivatives, of which only the methyl and ethyl[2] derivatives are known so far. 2-Sulphanilamido-4-*n*-propylthiazole has been synthesised as follows:

Butyrylchloride condensed with diazomethane in ethereal solution to yield the diazoketone (I) which on treatment with dry hydrogen chloride in ether solution yielded the corresponding chloroketone (II). On condensing the latter, with thiourea according to the usual procedure, 2-amino-4-*n*-propylthiazole (III) (picrate, m.p. 192° C.) was obtained. Treatment of this with acetsulphanilylchloride in pyridine solution furnished 2-acetsulphanilamido-4-*n*-propylthiazole (m.p. 202°) which on hydrolysis with

about 4 N hydrochloric acid yielded 2-sulphanilamido-4-*n*-propylthiazole (IV) (m.p. 143–44°).



(I)

(II)

(III)

(IV)

This method is of general applicability to synthesise the homologous compounds but we have not so far prepared them because our stock of chemicals was too limited and, moreover, the results of testing the 5-alkyl derivatives of sulphathiazole in this Institute have indicated that the therapeutic activity is greatly diminished in the homologous series after the propyl derivative. Accidentally, however, we have discovered a much better method of preparing the 4-alkyl derivatives[3] which consists in preparing the 2-acetsulphanilamido-4-alkylthiazole derivatives with an additional carboxylic ester grouping in the side chain and then treating them with hydrochloric acid or alkali which not only hydrolyses the acetamino but also the ester grouping causing subsequent decarboxylation. Details of this will be published later on.

We record our thanks to Lt.-Col. S. S. Sokhey, Director, for his kind interest in these investigations.

K. Ganapathi.
M. V. Shirsat.
C. V. Deliwala.

Haffkine Institute,
Parel, Bombay,
February 19, 1942.

[1] Ganapathi, Shirsat and Deliwala, *Proc. Indian Acad. Sci.*, **1941**, **14A**, 630.

[2] Lott and Bergeim, *J. Amer. Chem. Soc.*, **1939**, **61**, 3593; Bergeim and Lott, *ibid.*, **1940**, **62**, 1873.

[3] Ganapathi, Deliwala and Shirsat, *under publication.*

BIO-ASSAY ON TADPOLES OF THYROXINE AND SIMILAR PREPARATIONS

Numerous methods have been proposed for the biological assay of thyroid and its preparations. Burn[1] has advocated two methods based respectively on (i) loss in weight and (ii) increase in CO_2 production of small laboratory animals on systematic thyroid medication. These methods, though accurate, are time-consuming and are not easily and conveniently carried out in small laboratories. Gaddum[2] suggested a method depending on the measurement of changes in length and in the metamorphosis undergone by tadpoles as a result of a 24-hour exposure to a solution of thyroxine. Wokes[3] has recently found evidence to indicate that the tadpole test is trustworthy and accurate and can yield results comparable with the metabolic tests generally advocated.

Prof. B. B. Dey of the Madras Presidency College prepared thyroxine from natural and artificial (synthesis from iodination of casein) sources and requested one of the authors (B. M.) to undertake the biological assay of these preparations. This gave an opportunity of employing the tadpole method of bio-assay for the first time under Indian conditions. From the results obtained, it appears probable that the method could be used on a more extensive scale. Barring the fact that the availability of the tadpoles is limited to a particular season of the year, this method does not seem to have any serious defects. The action on tadpoles is specific for thyroid-iodine under the conditions of the experiment (24-hour exposure only), as it is not influenced by potassium iodide, which was also tried. Quantitative estimation of potency is fairly satisfactory, provided sufficiently large number of tadpoles are employed for the experiments to enable a correct statistical analysis of data.

Two varieties of tadpoles (*Rana tigrina* and *Bufo melanosticus*), which are commonly available in Calcutta, were employed in this investigation. The 'Rana' variety seems to be more suitable for work, as this has a longer life-cycle and metamorphic changes can be better watched. The experimental details were

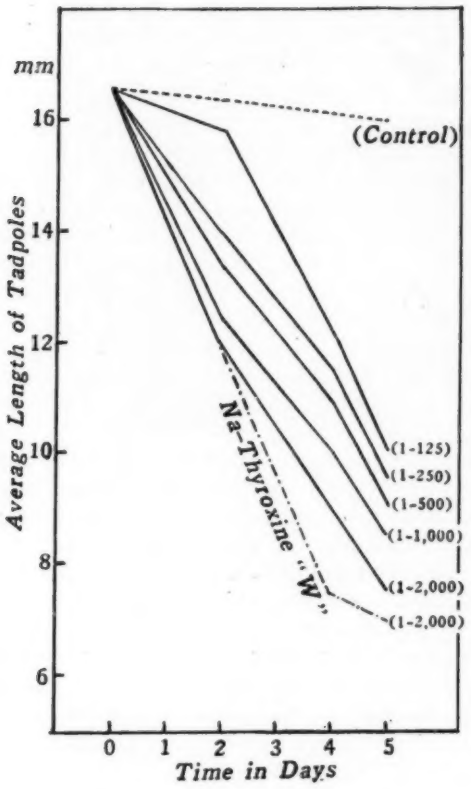


FIG. 1

FIG. 1. Effect of different concentrations of sodium thyroxine 'D' on average length of tadpoles (12 in each batch) after a 24 hour exposure. The dotted line (lower) shows the effect of sodium thyroxine 'W'. Concentrations are given in parts per thousand.

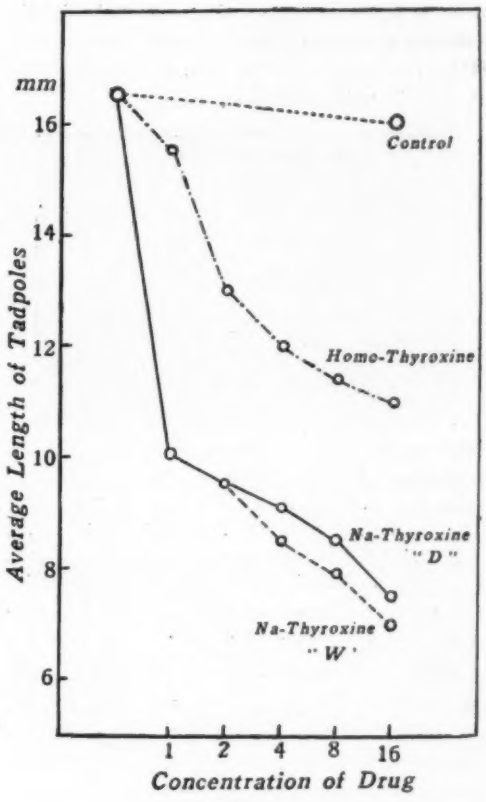


FIG. 2

FIG. 2. Comparative effect of sodium thyroxine 'W' and homo-thyroxine 'D' (synthetic). Exposure—24 hrs. Concentration—1 in 125,000. Average of 12 tadpoles in each batch. Time—5 days.

essentially those recommended by Gaddum and Wokes (*loc. cit.*). Minor modifications only were employed to suit the experimental conditions existing in the Laboratory. Twelve tadpoles belonging to the same clutch were used for each set of experiments. Thyroxine-sodium (B.W. & Co.), stated to contain 61 to 65 per cent. iodine, was used as the *standard* for comparison. The unknown samples tested were thyroxine-sodium prepared from desiccated thyroid gland (about 90 per cent. pure) and 'Home-thyroxine', prepared synthetically from casein (total iodine 34·8 per cent.).

The results obtained are plotted above showing *time-length* and *length-concentration* relationships of the tadpoles exposed to the various concentrations of thyroxine and homo-thyroxine for 24 hours. Normal controls and tadpoles treated with standard thyroxine-sodium (B.W. & Co.) are also shown. The photograph shows the stages through which the tadpoles pass to become fully developed frog. In this particular case, the metamorphosis has been brought about in 6 days what ordinarily should have taken 6 weeks to complete.

Pending statistical analyses of data, definite quantitative potencies of the natural thyroxine-

sodium and homo-thyroxine are not stated. Both preparations are however biologically active, the synthetic one being comparatively weaker in potency.

FIG. 3

Photo showing different stages of metamorphosis in tadpoles (No. 2 and 3) exposed to sodium thyroxine D' 10^{-6} for 24 hours: No. 1. Control tadpole. No. 2. Tadpole 3 days after exposure with marked protrusion of limbs. No. 3. Tadpole after 6 days showing shortening and extrusion of tail and looking like a miniature frog. The normal cycle takes about 6 weeks. (× 1·5.)

These and other results in this series seem to point to the fact that biological activity is probably more related to total iodine in thyroid preparations, rather than to thyroxine-iodine. This point is being more intimately investigated.

Our thanks are due to Prof. H. K. Mookerjee, Head of the Department of Zoology, University College of Science, Calcutta, for help in connection with securing the tadpoles and identifying them.

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February 18, 1942.

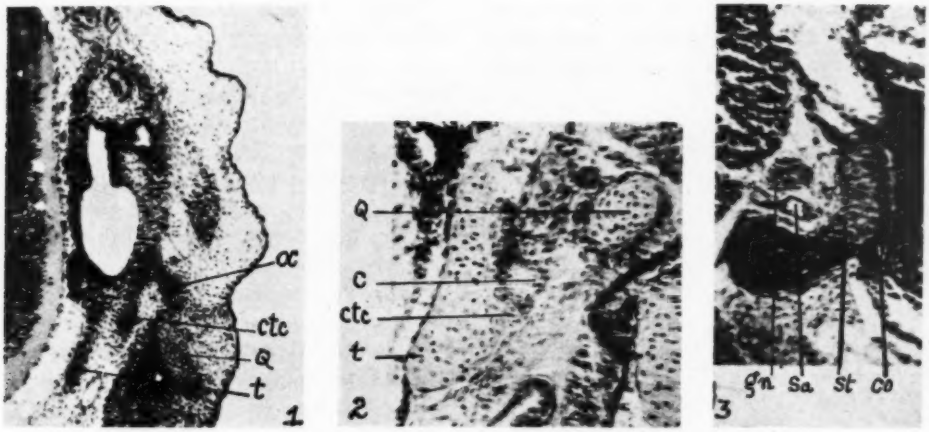
THE STAPEDIAL CONNEXIONS IN *ICHTHYOPHIS GLUTINOSUS* LINNÉ (APODA)

PETER[1] described in *Ichthyophis glutinosus* (Linné) embryos a stapes consisting of two parts; an anterior club-shaped cartilaginous columella enclosing the stapedial artery, fused with the quadrate and therefore derived from it, and a posterior rod-like cartilaginous operculum lying in the middle of the large foramen ovale. The operculum was of independent origin. In addition, he described an independently arising cell strand (Fig. 11, st. dist.) separate from the columella-forming proximal *Anlage*, which united with the columella *externally* to form the 'distal end' of it. As regards the further fate of this, he noted that it formed first a joint with the quadrate while a part of it became connective tissue uniting the stapes with a projection of os Basale.

Marcus[2,3] described the operculum as capsular and the columella as hyoid derivatives in *Hypogeophis*, thereby differing from Peter. Further, he observed that the distal process referred to by Peter was really a tiny process at the bend of the columella and this could not naturally follow the quadrate since the columella was posterior to the former. Such a process was not noticed in *Hypogeophis*.

Having examined embryonic and metamorphosing stages of *I. glutinosus* (Linné), I am in a position to clear the discrepancy with regard to this distal process. Fig. 1 shows clearly the stylus columellæ in union with the quadrate; this corresponds to the proximal *Anlage* of Peter. Internally to this is another process which starts posteriorly as a thin strand of cells and continues anteriorly by the side of the quadrate and unites with the columella as seen in the figure. This process, corresponding to Peter's distal end of stapes, therefore, unites *internally* and not externally as remarked by him. In a slightly older stage (Fig. 2), this process bridges the trabecula and columella anterior to the quadrato-columellar connexion. In Fig. 3 (a stage later than Fig. 2), the connexion has degenerated into connective tissue still uniting the lower part of

[1] Burn, *Biological Standardization*, 1937, 118.
[2] Gaddum, *J. Physiol.*, 1927-28, **64**, 246.
[3] Wokes, *Quart. Pharm. & Pharmacol.*, 1938, **11**, 521.



Sections of I. glutinosus embryos

Figs. 1, 2, 3. *c.*—columella; *oc.*—connective tissue bridge between stapes and otic capsule; *ctc.*—cartilaginous trabeculo-columellar connexion; *hm.*—hyomandibular nerve, *oc.*—otic connexion; *Q.*—Quadrate, *Sa.*— stapedial artery; *St.*—stapes; *t.*—trabecula.

otic capsule with the columella. This description of the final stage tallies with that of Peter, but he did not have the stage where the trabeculo-columellar union was noticed. This connexion is rather significant for we notice a similar one in *Hypogeophis*[4] (Figs. 3*a* and 9). The connexion in *Hypogeophis* is posterior to the otic articulation while in *Ichthyophis*, it is anterior, and therefore, Marcus, Stimmelmayr and Porsch[4] said that such a process was not discoverable in *Hypogeophis*. The trabeculo-columellar connexion seems to be peculiar to Apoda and as far as is known to me, is unparalleled in the vertebrate series.

L. S. Ramaswami.

Department of Zoology,
Intermediate College,
Mysore,
February 20, 1942.

[1] Peter, K., *Morph. Jahrb.*, 1898, **25.**
[2] Marcus, H., *ibid.*, 1910, **40.**
[3] —, *Anat. Anz.*, 1935, **80.**
[4] —, Stimmelmayr, E., and Porsch, G., *Morph. Jahrb.*, 1935, **76.**
[5] Ramaswami, L. S., *Nature*, 1941, **148**, 470.

SERRATIA SAMBHARIANUS: A NEW SPECIES FROM SALT LAKE OF RAJPUTANA

This new species of the chromogenic bacterium was discovered from the waters of the Sambhar Lake in Rajputana. Sambhar Lake is an inland salt-water formation fed by five saline rivers during the monsoon. It yields a large crop of sodium salts, including sodium chloride, which occurs in a far greater percentage as compared with sea water. This is, therefore, an economically important source of sodium chloride. However, the vast quantities of salt during the crystallisation of the brine turn reddish brown to red which decreases its value. Investigations were made to find out the cause of spoilation but it remained elusive for a long time. The senior writer was consulted by Dr. H. B. Dunnicliff, the Chief Chemist, Central Revenues, about this phenomenon as in his opinion it was due to the presence of some algæ in the water. The author carried out a series of experiments isolating each of the algæ but none was found to be a red colour producer. Ultimately, by employing the bacteriological technique and media he succeeded in obtaining chromogenic organisms belonging to Serratia group. The results were confirmed by

the joint author, who then independently carried out further investigations and concluded that it was a new species of Serratia which causes the "red heat". We propose the name *Serratia sambharianus* for this new organism.

This new species is much akin to *Serratia marcescens* Bizio. and *Serratia salinaria* Harrison & Kennedy but differs from both in various respects. *S. marcescens* cannot grow at 37° C., which seems to be its optimum temperature. *S. salinaria* grows in 16 per cent. to 30 per cent. salt but fails to grow beyond 30 per cent. salt, whereas this new species grows readily even in higher per cent. and relatively drier salt, which is really very remarkable.

The authors take this opportunity to thank Dr. H. B. Dunnicliff for his co-operation in enabling them to throw some searching light on this interesting problem.

S. C. Dixit.

Wilson College,
Bombay,

S. B. Vachha.

St. Xavier's College,
Bombay,
February 19, 1942.

A NOTE ON REARING THE LARVÆ OF THE MILK-FISH (*CHANOS CHANOS*)*

A study of the plankton present in the water of the Milk-Fish Farm was started from August 1941. On 11th August 1941, three larvæ found in the plankton, all of the same size (16 mm.), were successfully brought alive to the laboratory for rearing.

One of the larvæ was killed for immediate study. The following were the chief characteristics:—

(1) Transparent body with black eyes.

(2) Length, 16 mm.

(3) There were two rows of black pigments along the side of the body. On the caudal fin the pigments were scattered about; but there were no pigments on the other fins.

(4) The stomach and intestine were visible through the transparent body.

The other two larvæ were reared in a round glass-aquarium. As their body was transparent, the larvæ could be distinguished in water only with difficulty.

An aerator was used for the first ten days. The water in the aquarium was changed every day and fresh plankton was added every alternate day. After a few days the larvæ became so much used to the conditions of the laboratory that they seemed to recognise my coming by actively swimming towards me, especially in the morning at 8-30 A.M., when I supplied fresh plankton, on which they fed rather ravenously.

Within a week, the larvæ began to show signs of growth. The body began to lose its transparency. The dorsal side acquired a bluish tinge, which became more and more bluish as days passed by. The head became larger, and the body cylindrical. The ventral side of the body gradually became silvery. The larvæ became small fingerlings with adult characteristics in the course of a month.

One of the larvæ died on 18th September 1941 after living in the aquarium for over five weeks. Its length at the hour of death was 19 mm., the increase being 3 mm. The dorsal side of head and body was brilliant glossy blue in colour. The dorsal and caudal fins were blue; the pectoral, ventral and anal fins were white. The second larva died on 30th September 1941 after seven weeks. This larva also showed all the colour patterns noted above. Its length was 21 mm., the increase being 5 mm.

The larval characters noted above should enable a pisciculturist interested in rearing the Milk-Fish to distinguish its larvæ from other kinds of fish-larvæ.

P. I. Chacko.

Krusadai Biological Station,
Gulf of Mannar,
February 19, 1942.

* Published with the permission of the Joint-Director of Industries and Commerce, Madras.

EMBRYOLOGICAL STUDIES IN PALMÆ (A PRELIMINARY NOTE ON THE MEGASPOROGENESIS IN *ARECA CATECHU* LINN.)

THE review of literature on Palmæ given by Schnarf[1] and Schürhoff[2] reveals the paucity of work on the subject. There is considerable difference of opinion between different investigators about the mode of development. A re-investigation of several members of the family Palmæ is taken up by the author and a preliminary note on the megasporogenesis of *Areca catechu* Linn. is presented here.

There is a single basal, erect ovule in each ovary. The archesporial cell cuts off 4 to 6 parietal cells and the megaspore-mother cell becomes deeply placed. The development of the embyo-sac conforms to the Normal-type. The embyo-sac enlarges in size and the surrounding nucellar cells become disorganised constituting nutrition. Consequently the embryo-sac shows very irregular contour. The synergids are about the same size as the egg. The antipodals are persistent and become aggressive. The surrounding nucellar cells are depleted of their cell contents and the antipodals might be haustorial in function. The nuclei of the antipodal cells show marked hypertrophy.

B. G. L. SWAMY.

Bangalore,
February 25, 1942.

[1] Schnarf, K., Vergleichende *Embryologie der Angiospermen*, Berlin, 1931.
[2] Schürhoff, P. N., *Die Zytologie der Blutenpflanzen*, Stuttgart, 1926.

A NEW PHANEROGAMIC PARASITE OF SUGARCANE IN BENGAL

THAT the sugarcane suffers from attack of phanerogamic parasites[1,2,3,4] is well known. The parasitic weed *Striga*, causing sometimes a good deal of damage in sugarcane crop, is not uncommon in India and in other countries. *Æginetia indica*, of the family *Orobanchaceæ*, has been known as a parasite on sugarcane in India and other tropical cane-growing countries, while a second member of the same genus, *A. paniculata*,[4] is reported from Burma as another parasite on cane. Though *Æginetia pedunculata* has been seen to occur as a parasite[1] on grasses, no such report of its parasitisation on sugarcane would appear to have been recorded so far.

During the months of June and July, 1940, many clumps of sugarcane were observed in some localities of the Munshiganj Sub-Division, Dacca, that were apparently suffering from some sort of disorder. The clumps were examined and clusters of flowers were found emerging out of the soil at the bases of the cane plants (Fig. 1). The flowers were later

FIG. 1

Clusters of floral stalks and flowers of *Aeginetia pedunculata* showing attachment with roots of sugarcane. A—roots of the parasite; B—roots of sugercane.

identified to be of the species *Æginetia pedunculata* Wall.

To find out what relationship this flowering plant had with the diseased appearance of the sugarcane clump, the latter with the flowers was taken out of the ground with the root system intact and the whole carefully washed to remove the adhering soil. *Æginetia pedunculata* was found to produce a short, soft, thin underground stem, 4–6 inches long, having small fleshy scales over its body and to send out pedicelled (2 to 4 inches) flowers above

the soil surface. The flowers, 1½ to 2½ inches in length, were conspicuous by their bright violet colour and the aggregation of corymbs. Short rather stout and soft scapes, long bracteate pedicels, bright violet limbs, 2-lamellate placentas and mucilage loaded spathaceous calyx were all there to distinguish this species from *A. indica* Rox., the only other species of the genus known in India.

The roots of the parasite were found to form a thick tangled mass with those of the sugarcane. They formed organic connections with the thinner roots of the cane and thus drew upon the sugarcane host. Sometimes a knob-like swelling was seen upon the parasite root at the point where it formed connection with that of the cane. The attacked canes or clumps were stunted in growth with withered and dried leaves. In the early stages of attack, the outer leaves seemed to be affected first with withered edges and the midribs alone remaining green. In case of severe attack the clumps might die altogether. The effect due to the related species of this parasite on sugarcane is known as "bunga"[3] and the same name might be applied in this case also.

In the control of this parasite, the infected clumps should be dug out and eradicated as soon as the flowers become visible and before they form seeds. If the parasite is left to seed and the seeds, minute and numerous, mature then the parasite comes out in large numbers the next season. Setts for planting should be selected from fields free from the attack of the parasite. Further control measures are being tried, the results of which will be published in due course.

S. HEDAYETULLAH.
J. C. SAHA.

Section of Economic Botanist,
Agricultural Research Station,
Dacca,
February 9, 1942.

[1] Hocker, J. D., *The Flora of British India*, London, 1885, **4**, 320.
[2] Luthra, J. C., *Agri. J. India*, 1921, **16**, 519.
[3] Roxas, M. S., *Sugar News*, 1927, **8**.
[4] Subramaniam, L. S., *Imperial Council of Agri. Research, India, Miscella. Bull.*, No. 10, 1936.

THE MANUFACTURE OF GLANDULAR PRODUCTS IN INDIA

WHILE it is gratifying to note that several laboratories in this country have been making original contributions to the chemistry and therapy of Vitamins some of which are being quoted with appreciation in foreign scientific journals, it is to be regretted that few, if any, of our institutions have undertaken systematic research in the field of Hormones. This is probably due to some extent to the difficulties which are inherent in hormone-research but more to the fact that for such work to be really fruitful a better and more intimate co-operation between the chemist and the clinician is necessary than obtains at present in India. The incorporation recently of a department of Pharmacology in the Chemistry Department of the Institute of Science, Bangalore, is from this point of view to be regarded as a move in the right direction.

Glandular products like insulin, adrenalin, liver principles, pituitary concentrates and sex hormones have now become indispensable for the comforts of modern life, but we are at present entirely dependent on foreign imports for these essential drugs. The war of 1939 which has now blazed into a real World War has completely cut off our supplies of these medicinal products and we are consequently faced with the dire necessity of either developing our own resources or of going without these drugs. India is reputed to possess nearly a third of the world's population of cattle and it is the slaughter-houses of our principal cities which should mainly provide the raw materials for these drugs. Statistics obtained through the kind services of the Board of Scientific and Industrial Research in Calcutta show that nearly two and a half millions of sheep and goats and three and half lakhs of cattle (bullocks, buffalces, cows and calves) are slaughtered annually in the cities of Bombay, Calcutta, Madras, Delhi, Karachi, Lahore, Lucknow and Dacca. These figures compare favourably with animals slaughtered in the slaughter-houses of London or even of a typical Packing House in Chicago.

The commercial manufacture of the important glandular products in India should not offer any insurmountable difficulties. I understand that investigations on the preparation of insulin are being vigorously pursued in the Bio-chemical laboratories of the Institute of Science, Bangalore, and the work carried on in my laboratory for the last one year on the preparation of the active principles of thyroid, and latterly of adrenal glands, has yielded results surpassing all reasonable expectations. The biological assay of such hormones as insulin, thyroxin and adrenalin which can be obtained in a pure crystalline condition is of course not a difficult problem and may be considered to be of only secondary importance, but in the cases of the other gland products like pituitrin, the anti-anæmic principles of liver or the sex hormones, strict biological control at every stage of the operations involved in their preparation is essential. The recently instituted Biological Standardisation Laboratory attached to the All-India Institute of Hygiene in Calcutta, appears to have excellent facilities, though on a small scale, for undertaking work of this nature. It is most to be desired that these facilities were improved and extended and arrangements made under which the active co-operation of this central laboratory with other chemical laboratories which may be recognised as important centres of hormone-research in India would be possible.

It would of course be very unreasonable to expect that factories on the lines of the Eli Lilly or the Lederlie laboratories in the U.S.A., or of the Boots laboratory in England, would emerge overnight as a result of these researches but there seems to be no reason why it should not be possible to make a beginning in the form of a pilot factory preferably in a central place in India which might very soon be in a position to supply at least the urgent war-time demands in the country.

B. B. Dey.

Presidency College,
Madras,
February 25, 1942.

ON AN "IMPROVED METHOD FOR THE DETERMINATION OF PROTHROMBIN TIME"*

The real question, in my view, is whether the change in the technique (preparing the solution of thromboplastin, be it from rabbit's brain or from venom in calcium chloride instead of having two separate solutions and adding calcium to the mixture of plasma and thromboplastin) does really shorten the prothrombin time as a rule. A fuller record of results could not be included in a short note. In our experience there was no shortening at all, when the test was done using thromboplastin from rabbit's brain and following the technique of the improved method, namely, preparing the thromboplastin in calcium chloride, thus increasing the concentration of prothrombin in the reaction mixture and also bringing the calcium and thromboplastin together before adding to the plasma.

A minor consideration is whether the reduction of prothrombin time to the extent of 8 seconds is an advantage to the laboratory worker and even if it is considered so, are the results likely to be as accurate as with 'prothrombin time' determined according to Quick's method?

D. V. S. Reddy.

Andhra Medical College,
Vizagapatam,
January 19, 1942.

* *Cf.* this Journal—1941, **10**, 326 ; 1942, **11**, 60, 61.

INDUCTION OF POLYPLOIDY IN CROP PLANTS

BY

L. S. S. KUMAR AND A. ABRAHAM

(*College of Agriculture, Poona*)

CYTOLOGICAL studies have shown that about half the species of investigated angiosperms are polyploids, as inferred from the presence of chromosome numbers in multiples of that found in some related species. While this is the condition in nature, the attempt to artificially induce polyploidy has met with any marked success only recently. The investigations of Blakeslee and Avery[1] have shown that of the many methods tried to uniformly double the chromosome number and thus obtain seeds with the doubled number, the application of the alkaloid colchicine is by far the best. Extensive work in this new field is in progress in America (Blakeslee[2]). But so far we have come across only five reports of successful application of colchicine on Indian crop plants (*cf.* Pal and Ramanujam[3]; Amin,[4] Richharia and Persai[5]; Pal, Ramanujam and Joshi[6]; and Ramanujam and Joshi[7]).

The present note deals with the technique adopted in inducing polyploidy in *Phaseolus radiatus* L. (*mug*) and a comparison between the diploid and tetraploid. Similar studies on a number of other crop plants are in progress.

Technique.—In the application of colchicine various methods are used (*cf.* Derman[8]). The optimum dosage and the best method of application of the drug varies from species to species. We tried different methods of applying colchicine with varying degrees of success.

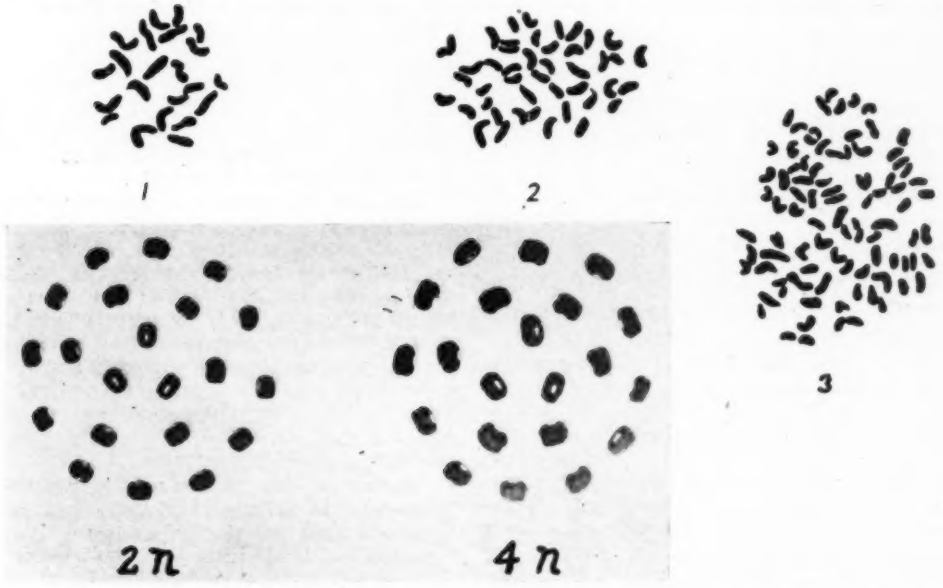
The method we found most successful with *mug* was applying 0·4 per cent. colchicine in agar to the apical bud after the first pair of leaves had developed. This treatment stunts the growth of the bud considerably and its development is delayed very much. By treating in the above manner we got four plants out of twenty definitely tetraploid, while from some others not examined critically, a mixture of diploid and tetraploid seeds may be expected. Examination of epidermis of strictly comparable leaves (the first fully opened leaf below the apical bud in comparable branches) showed that in at least one plant octoploidy had resulted.

Seed treatment was not successful; the chief cause of failure appeared to be the drastic effect of the drug on roots, which failed to produce lateral roots or to show any appreciable development after treatment.

Cytological Examination.—Chromosome counts were made from root tips obtained from seeds of the artificial tetraploid (as determined earlier from pollen examination) and from the diploid controls. As the number of first generation tetraploid seeds was small, the germinated tetraploid seeds from which root tips were taken were carefully planted in earthen pots and they developed into vigorous tetraploid plants and produced a number of pods.

In the cells of the diploid there are twenty-two chromosomes while in the tetraploid there are forty-four chromosomes. Figs. 1 and 2 are Indian ink drawings made on photomicrographs showing metaphase plates from root tips of the diploid and tetraploid respectively. Two satellited chromosomes were seen in the diploid complement, though due to the smaller size of the chromosomes, the four satellited chromosomes which should be expected in an autotetraploid were not distinguished in the cells of the tetraploid. But prophase nuclei showed four chromosomes attached to the nucleolus. Also the nucleolus in the tetraploid is much larger than in the diploid.

In certain characters tetraploids differ from diploids and these are of value in detecting polyploids without actual chromosome counts. In tetraploids the leaves are thicker with larger cells and plastids compared with diploids. This gives the leaves a distinctly greener appearance and is a fairly accurate guide in distinguishing affected branches from unaffected ones, especially where sectorial chimeras have arisen as a result of treatment. Epidermis from strictly comparable leaves show an increase in size of cells and stomata



FIGS. 1–3.—Metaphase plates from root tip cells of the diploid ($2n = 22$), of the tetrapoid ($4n = 44$) and of a sectorial chimera ($8n = 88$) respectively. × 2400. Drawings made from photomicrographic prints.

FIG. 4.—Photograph of seeds from diploid ($2n$) and tetraploid ($4n$) to show the increase in size of seeds as a result of chromosome doubling (Nat. size).

in the tetraploid while the number of cells is less. Pollen size, which is a surer index of ploidy, has invariably shown that there is an increase in size of pollen grains with increase in chromosome number.

Consequences of Auto-polyploidy.—Natural as well as artificial polyploids are distinguished from their diploid progenitors by the presence of *gigas* characters—thicker stem, greater vigour, thicker leaves with darker green pigmentation and larger flowers and seeds. However, in colchicine induced polyploids, in the first generation, the plants are more stunted than the diploids. This is evidently due to some inhibiting effect of the drug. But in the second generation, the offspring from tetraploids showed much greater vigour and appeared more hardy than diploid controls. We have found that in both the first and second generation tetraploids, the seeds are distinctly larger than those of the diploid (Fig. 4).

In chemical constitution also the tetraploids show many differences. Sansome and Zilva[9] have found that tetraploid tomatoes have twice as much vitamin C as the diploid. Randolph and Hand[10] found a tetraploid strain of maize to contain 43 per cent. more carotinoid per gram of dry meal than the corresponding diploid. This shows the possibility of increasing the nutritive value of plant products by doubling the chromosome number. Studies on the food content of the tetraploid seeds will be undertaken as soon as sufficient seeds have been procured in the third generation.

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[6] Pal, B. P., Ramanujam, S., and Joshi, A. B., *Ind. J. Genetics and Plant Breed.*, **1941, 1,** 28.
[7] Ramanujam, S., and Joshi, A. B., *Ind. J. of Ag. Sci.*, **1942, 11,** 835.
[8] Derman, H., *Bot. Rev.*, **1940, 6,** 599–365.
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[10] Randolph, L. F., and Hand, D. B., *Science*, **1938, 87,** 442.

REVIEWS

Landscape. By C. A. Cotton. (Cambridge University Press, London), 1941. Pp. xviii + 301. Price 21/.

This book makes a systematic study of the various forces which are at work shaping the earth's surface, and by means of a really excellent series of line drawings of actual models, shows most vividly how an infinite variety of landscape features can be produced.

Much that has been written recently about soil erosion gives the impression that it is a new development, which of course is wrong. The *pace* of erosion has been undoubtedly altered by man's actions, but erosion is actually one of the oldest factors in the fashioning of land surfaces. It has in fact been at work since the first land surface appeared out of the ocean. Uninterrupted erosion of any raised land mass would tend to reduce that surface to one continuous plain sloping gently to sea level, but this is counteracted by intermittent geological uplift by which new areas are raised up. Some parts of the earth's surface have been worn down over and over again in the course of geological time. No feature of landscape is a finished form; mountains themselves are transient forms when considered in terms of geological development.

For anyone who travels much in India this book will repay study, for the familiar features of plain and mountain and coast all appear in easily recognisable form, and immediately take their place in the geographer's deductions. The reader becomes Dr. Watson to the author's role of Sherlock Holmes as he unravels the fascinating story of how such freakish features of landscape have arisen as bad-lands, tors, hoodoo columns, earth pillars, pot-holes in stream beds, buttes, rock bridges, and so forth. Starting from the simplest geological form of a gently raised and slightly undulating countryside, as when a coastal plain first becomes dry land, the author develops logical reasons for the apparent vagaries of nature when she produces such things as the capture of one river's drainage by another, or the immensely deep gullying along river banks such as we see in the Betwa and Chambal ravine areas of the Jumna basin, and the amazingly intricate patterns of curves which a river can produce during its meandering across a plain.

Although most of the author's actual examples are culled from New Zealand, Europe, Japan and the western states of the U.S.A., the basic characteristics of land sculpture by normal erosion processes are so clear that one is constantly meeting formations that can be recognised as Indian. Of the various chapters possibly that of most interest to India is on the meandering of rivers, though the author does not follow it far enough into the flat plains to satisfy the irrigation engineer.

Another omission, if one may be permitted to indulge in a little constructive criticism, is that actual desert conditions are hardly referred to, and none of the photos or diagrams depict a desert or the freak landscapes which are found where wind plays endlessly with desert sand. The man-made sand dunes of the west coast of France, possibly the greatest single contribution so far achieved by land planners, is not mentioned, though hundreds of square miles both north and south of Bordeaux estuary have been transformed from malarial swamps into vineyards and pine forests sheltered from Atlantic gales by these artificially created dunes.

In discussing run-off and the fate of rain, one would have liked to have something more definite than: "Not all the water with which rivers are fed reaches the sea", and thereafter the enumeration of evaporation and soakage in river beds as accounting for such losses. Actual corrosion (or mechanical cutting and scouring of its banks and bed by a river) is many times greater in floods than at ordinary levels, so the measure of a river's capacity to produce heavy floods is to some extent a measure of its capacity to alter the landscape. In this connection some reference to the various attempts to locate and assess areas of serious erosion within important river catchments in America and India would have been apposite. Also a fuller description of bad-land topography and the conditions under which it develops would have been of value; this is dismissed in a few

words, and the single photo given for this feature is not at all typical.

One further word of criticism is that in the discussion of the movement of massive boulders along river beds, no emphasis has been placed upon the enormous powers for mischief possessed by mud flows as compared with mere water power. In many Himalayan valleys one meets isolated boulders weighing perhaps as much as 300 tons, which could not conceivably have arrived where they are by means of water action or gradual undercutting and rolling. The answer invariably is to be found in the thick and porridgy mud-flows which follow any major land-slide. These act like a cement cushion on which enormous weights can be moved for long distances before being deposited.

Apart from such minor points, which do not really detract from the value of the book, we should appreciate Professor Cotton's contribution to the study of landscape as being of the greatest value, not only to those engaged in geology and geography, but also to the average thinking citizen who prides himself on knowing the reasons for what he sees around him.

R. MACLAGAN GORRIE.

The Second Year-Book of Research and Statistical Methodology (Books and Reviews). Edited by Oscar Krisen Buros. (The Greyphon Press, Highland Park, New Jersy), 1941. Pp. xx + 383. Price $5.00.

This is the author's second attempt, the first one being his similar compilation in 1938, at giving to persons interested in statistics a resume of reviews on books containing statistical methodology and other allied topics. As noted by the author in his Preface the book mainly aims at helping students, teachers and librarians to select text-books with greater discrimination, to point out to them weak and strong points of particular books as also the marked differences of opinion among the more advanced students of statistical theory, to raise the standard of reviews and incidentally the standard of books on statistics, etc. One has only to look to the exhaustive periodical directory and Index, appended towards the end of the book to appreciate the amount of labour put in with a view to achieve these ends. Going through the details of the excerpts published, one finds that they have been chosen very carefully, representation being given to favourable reaction of reviewers as also to their adverse criticism. Although the book is a massive collection of reviews, it is by no means devoid of interest to the general reader interested in studying different trends of thought in various branches of statistical science.

For an Indian reader, one of the chief shortcomings of the present volume is the omission of references to well-known journals in India. For instance, there is no reference to the important quarterly, *The Indian Journal of Economics*, running in its 22nd volume, as also to *Science and Culture*, a popular scientific monthly, of about seven years standing. *The Indian Medical Gazette*, which has a wide circulation outside India, is another notable omission. The reviewer feels confident that if co-operation is sought from such periodicals it will be certainly forthcoming. As a result of this some good Indian books containing statistical information which have been favourably reviewed outside India, do not find a place in this compilation. Dr. Gyan Chand's *India's Teeming Millions*, Prof. Radha Kamal Mukerji's *Planning Food for 400 Millions* and Dr. Rao's *India's National Income*, are few of the notable omissions.

One of the several improvements over the 1938 compilation according to the author is that the excerpts presented in this Year-Book are longer and more informative than those in the first volume. It seems to the reviewer that some of the reviews incorporated here are unnecessarily long. Many of them run into three columns whereas a review on Hull's *Mathematic-deductive Theory* is longer still and another on Burt's *The Factors of Mind* occupies as much as seven columns. One, therefore, naturally feels the necessity of fixing an upper limit as well to the reviews reproduced if that could be done without loss of valuable information. Reviews of the same book by the same person in two different periodicals have been reproduced (Ref. p. 111, col. 2). This should be avoided especially when such space could be better utilized.

In the future compilations of this type the author has promised to introduce a section devoted to non-critical abstracts of voluminous periodical literature in statistical

methodology. This will certainly be a welcome improvement especially because former attempts in this direction like Dr. Irwin's *Recent Advances in Mathematical Statistics* and Wishart's *Bibliography of Agricultural Statistics* published in the Journal of the Royal Statistical Society were favourably received by statisticians and were highly useful to research workers. But the reviewer is afraid that such a publication will occupy a lot of space in view of the growing volume of literature in this subject, even if it is restricted to papers written in English.

Looking to the reviews on the 1938 Year-Book, published in this volume, the reviewer is satisfied to find that the author has incorporated almost all the useful suggestions given by the previous reviewers. There is, however, one which seems to have escaped the author's notice and that is the classification according to subject. Such an Appendix along with others given in the present volume will be very useful.

B. N. DATAR.

A Text-book of Intermediate Physics (in Tamil). Vol. I. By R. K. Viswanathan, M.A., and V. N. Ramaswamy, B.Sc. (HONS.), Annamalai University, 1941. Pp. lxxi + 686.

The problem of scientific terminology in Indian languages is a very live one, and has recently been ably discussed in a leading article in *Current Science* (October 1941, 10, No. 10, p. 425). The immediate objectives are two, first the dissemination of the trends in modern scientific ideas and achievements among the general public so as not only to make them appreciate the benefits but also to co-operate intelligently in the wide and beneficial application of the scientific principles in present-day life and civilization. The other important objective is to help in the teaching of the basic principles of science to the school boys, the majority of whom must inevitably take to various professions after their general school education. There is yet another possible objective, namely, provision for advanced study in undergraduate classes, and for independent research in science through the medium of the Indian languages. This is not necessarily a "logical extension" of the former objective, as claimed in the brief preface to the book under review. Those in the research field are feeling already the barriers to intercommunication of ideas—so necessary for rapid advance and avoiding of wasteful duplication of work—on account of the various attempts during the last decade at publishing Journals in other European and Asiatic languages than English, German and French. If still, there is to be any development towards this third objective, it should be nothing short of an all-India uniformity and approximation to international phraseology.

The book under review on "Intermediate Physics" is written in free Tamil, and may be regarded as an aid to the more advanced general science education in the pre-university classes. It is indeed a laudable achievement. The get-up of the book is good, and the planning and presentation of the subject are along the routine lines. Almost all of the scientific terms coined have the desirable qualities of simplicity, precision, euphony and above all intelligibility and are deserving of wide currency. The book is, however, defective in one important feature, *viz.*, lack of any good diagrams. As active teachers, the authors must no doubt be aware that diagrams are just as important as the language to convey the ideas across to the students and must be given the same careful consideration of simplicity, precision and intelligibility. Such diagrams as of the Bunsen ice calorimeter with the right-angled bends of the capillary tube, the "giant" test tube and "magic" retort stands of Fig. 204 on page 639, the "pestle" like thermometers on page 471, and the "floating" stopper in Fig. 197, are typical of the glaring defects in all the diagrams. There are but few typographical errors; incidentally the authors use throughout italic c instead of capital C for the Centigrade scale. These and similar defects must be remedied in future editions, if the value of this otherwise excellent book must be kept up.

M. A. G. RAU.

Diffusion in and Through Solids. By R. M. Barrer. (The Cambridge University Press, London), 1941. Pp. x + 464. Price 30 *sh.*

The study of diffusion touches upon numerous aspects of physico-chemical research, and is of fundamental importance for the large number of problems involving transfer of materials by diffusion from one phase to another that are repeatedly

encountered in Chemical Engineering operations. The book under review is, however, confined to the study of diffusion in and through solids, a subject which presents a whole set of new phenomena and is frequently composite in character on account of the possible interactions between the diffusing material and the diffusing medium. These studies should be also of great help in understanding the fundamental nature of the technically more frequent phenomena of diffusion across stationary fluid films, a topic which does not fall immediately within the scope of the title of the book.

The author deals with the several processes of permeation, solution and diffusion in solids, the theories concerning their interpretation being balanced by an adequate description of the experimental methods and results. The first chapter gives a number of solutions of the diffusion equation suitable for treating the various diffusional problems that may arise. Chapters 2, 3, 4, 5, 9 and 10 deal in detail with the diffusion of gases and vapours through a variety of inorganic and organic structures. This covers the technically important subject of uptake and evolution of gases by metals, and the numerous studies made of gas flow through rubbers, fruit and food wrappings, insulators, leathers and paint and varnish films. Chapters 6, 7 and 8 describe the phenomena of conductivity and diffusion of ions and atoms in ionic lattices, metals and surfaces. These involve a knowledge of equilibria between holes, interstitial ions, and normal lattice and other structure sensitive factors. Such fundamental studies are capable of yielding much information on phenomena such as annealing, age-hardening, plasticity, recrystallisation and alloy transformations.

Throughout the book, adequate numerical values of permeability and diffusion constants for various systems have been collected and listed in the relevant chapters to serve as reference material. On the whole this book is a valuable addition to the Cambridge Series of Physical Chemistry. M. A. G. RAU.

Dipole Moments in Chemistry. By Dr. M. A. Govinda Rau. (The Registrar, The University of Madras), 1940. Pp. 64. Price As. 8.

This is a reprint from the *Journal of the Madras University,* Vol. XII, No. 2, 1940, and is the subject-matter of a series of three lectures delivered under The Sir Subramanya Ayyar Endowment scheme of the Madras University. The author has himself worked extensively on the subject, and has made some very definite contributions to the advancement of our knowledge on Dipole Moments, and their bearing on the structure of Chemical Molecules. This subject covers a field in which both physicists and chemists are deeply interested. The first lecture reviews in an effective and elegant manner the physical significance of dipole moment measurements, and the experimental technique. The second lecture is a lucid exposition of the relation between dipole moments and the structure of molecules and is developed on extremely interesting lines, while the third lecture deals with the complex subject of dipole moments and chemireactivity.

This publication makes available to all those interested in the subject a very stimulating and helpful account. There is a choice Bibliography covering the subject up to 1939.

Shells and Other Animal Remains Found on the Madras Beach. By F. H. Gravely. (*Bulletin of the Madras Government Museum.* Natural History Section: Vol. V, No. 1), 1941. Pp. 112. Price Rs. 3–2.

In writing this memoir the author has made a valuable contribution towards our knowledge of the coastal fauna of Madras. It has been written in such a way that it satisfies the needs of not only a student of Zoology but also a layman interested in the natural history of coastal animals. As the author himself points out, the object in writing this book has been to interest and help the casual collector rather than the specialist. As far as possible technical terms have been replaced by simpler ones. All the forms have been classified and arranged in a systematic manner from Protozoa to Chordata. Under each phylum, the common forms are described in simple terms illustrated with figures. Wherever necessary, key for the identification of the genera and the species has been given. At the end, a list of identified genera and species of the Madras Beach has been given together with references to the literature pertaining to these animals.

One who has been in charge of the

teaching of Zoology in any of the Indian Universities will greatly appreciate the value of this memoir. The specimens of animals collected on the seashore by parties of students are not often used to the best advantage for want of adequate and ready literature for the identification and study of the forms. This *Bulletin* will prove to be a valuable guide both to the casual collector and advanced students of Zoology in their study of the shore fauna.

B. S. B.

Ramalinga Reddy Sastyabdapurti Commemoration Volume: Part I—Sciences. (Andhra University, Waltair). Pp. vii + 234. Price Rs. 10 or 14*sh.*, postage extra.

The articles that were presented to Sir C. R. Reddy by scientists from different parts of India on the occasion of his *Sastyabdapurti* are published by the Andhra University in a collected form. This volume contains two papers dealing with physics, fifteen papers dealing with chemistry and chemical technology, one dealing with surgery and three dealing with mathematics. A photograph of the bust of Dr. C. R. Reddy which was made by Mr. D. P. Roy Chowdary and unveiled by H. E. Sir Arthur Hope and three portrait sketches of him prepared by Mr. K. Ram Mohan Sastri are also reproduced in this volume.

The volume opens with a paper by Sir C. V. Raman and Dr. N. S. Nagendra Nath in which is given a self-contained theoretical exposition of the new type of X-ray reflections. This subject has recently been investigated in great detail at Bangalore and is now attracting the attention of several prominent physicists. This is followed by an article in which Dr. I. Ramakrishna Rao describes the many interesting properties of water and shows how they can be accounted for by considering the complex structure of this liquid. In the next two papers, Dr. H. K. Sen and Dr. J. C. Ghosh deal respectively with the planning of Scientific and Technical Research in India and the War and its Repercussions on the Chemical Industries in India. Nitrogen fixation, photosensitization, chemistry of medicinal oils, of the constituents of lichens, of the bitter principles of some fruits, etc., are amongst the subjects dealt with in some of the other papers. A brief account of the evolution of aseptic surgery since the time of Pasteur and Lister has been given by Prof. M. G. Kini. The last three papers of the volume, which are devoted to mathematics, respectively deal with some fundamental limits in analysis, Liouville's theorem and a theorem of Estermann in the additive Prime Number Theory.

A perusal of the names of the authors that have contributed to this volume shows that many distinguished men and specialists from all over India are amongst them. The subjects dealt with, cover a wide range of interests and this is a clear indication of an active era of original scientific work having started in this country. It is gratifying to note that the sale proceeds will be utilized for the benefit of the Andhra University. The volume will be a welcome addition to one's library both as a compendium of useful work and as a reminder of the esteem in which an eminent educationist like Dr. C. R. Reddy is held by the several contributors to the volume. The printing is good. The get-up is rather simple but could have been more attractive. S. B.

Punjab Irrigation Research Institute: Report for the Year ending April 1939. (The Punjab Irrigation Research Institute, Lahore), 1940. Pp. 189.

The Research Institute, during the year under report, undertook a number of investigations of engineering interest.

Soil profiles of the Punjab Alluvium were examined and in no case a rising water table was found to pierce the soil crust which generally overlies a sand stratum. In an unirrigated area, the top five feet of crust was found to have the greatest variation in salt and even when salt had very large vertical movement, it was found to have very little lateral movement.

In the case of earth roads, moisture largely contributed to the preservation of road surfaces and prevention of dust nuisance. Salt in the soil is an important constituent determining the moisture content of a soil, the hygroscopicity of a soil increasing with increasing salt concentrations. Sodium chloride has been found to be valuable in promoting moisture retention, while sodium sulphate, even in small quantities, has been found to disrupt the surface. Cohesion in dry soils depends on the clay content and the fineness of particles. The effect of exchangeable bases on soil cohesion

was found to be a maximum when the soil was dry and the order of cohesion for the dry soil followed the order of dissociation for the ions, *i.e.*, Li > Na > K > Mg > Ca.

An apparatus for measuring the capillary force of sand was devised which also serves for a rough and ready determination of the mean diameter of sand. Experiments have not indicated that the discharge of a tube-well is proportional to the area of the strainer, but there appears to be an optimum size of the shrouding material with respect to the grade of the water-bearing sand. An attempt has been made to detect cavities under weirs by means of an apparatus causing vibration by impact, the amplitude of vibration being naturally greater for unsound work.

A mud plaster, non-erodable under rainfall or flowing water has been got at, by the addition of 5 per cent. cement by weight to the Punjab soil generally containing about 15 per cent. of clay. Lining of some minors and water courses on two large farms with mud plaster, has considerably reduced leakage.

Factors contributing to the formation of Thur were studied during the year and several areas were taken for reclamation. Data were collected regarding the discharge of open wells, water requirements of crops and cost of this form of irrigation. It has been shown that generally a farmer gets a higher profit per acre on the introduction of tube-well irrigation than in the case of open well irrigation.

Frictional drag exerted by different grades of sand bed on the flow of water in a channel, and movement of silt in a tilting flume are being studied. Examination of the hydraulic observations on the Mississippi river published by the U.S. Waterways Experimental Station, Vicksburg, has shown that the slope-discharge-silt formula of the Irrigation Research Institute agreed well with the observed values.

Experiments on a model of the river downstream of Panjnad weir with a view to control erosion indicated that a two T-head spurs properly disposed would arrest erosion. Work is also in progress on models of the River Chenab in connection with problems connected with river training and silt entry into canals. Silt surveys of the Upper Bari Doab Canal, the Lower Chenab Canal and the Western Jumna Canal were also undertaken.

After a small shower of rain or after irrigation, a rise in water-table much greater than can be accounted for, takes place. A study is being made to determine the cause of this phenomenon, probably the result of negative pressures developed in water films surrounding soil particles. A survey of wheat soils with reference to yield and the chemical constituents of the soil indicates that soils having a high yield of wheat have a low manganese and high available phosphate content.

The Research Institute has been engaged during the year on a variety of useful and important engineering problems.

C. GOPALAKRISHNAN.

The Indian Cotton Textile Industry (1941 *Annual*). (Gandhi & Co., Calcutta), 1941. Pp. 150. Price Rs. 3 or 9*sh*.

The 1941 Annual of the Indian Cotton Textile Industry has been published by Messrs. Gandhi & Co., and is a handy and useful reference book for all that are engaged in the cotton textile industry. As in the previous year, the statistical figures for imports and exports of cotton, yarn and cloth are incomplete as their official publication is withheld owing to war conditions. The various details are arranged in a systematic and clear manner as in previous issues of the Annual.

A more detailed survey of the working of the Handloom Weaving Industry in various Provinces and States might, perhaps, have been much appreciated, particularly in view of the fact that the Handloom Weaving Industry occupies such an important part in the economics of the Indian cotton industry and is passing through a period of acute depression for want of adequate supply of yarn and other raw materials at reasonable prices.

B. K. MURTHY.

PROGRESS OF AGRICULTURAL RESEARCH IN INDIA

Annual Report of the Imperial Council of Agricultural Research, 1940-41. (Manager of Publications, Delhi), 1942. Pp. ii + 190. Price Rs. 2-12-0 or 4*s*. 6*d*.

THIS is the eleventh annual report of the Imperial Agricultural Research Council since its inception and summarises the main features of the work of the year. Nearly all the research schemes of the previous year have been in progress and many other schemes were sanctioned during the year and others have been under consideration. The schemes under agriculture proper have related to nearly every aspect of the main classes of crops and number as many as fifteen with a budget allotment of about Rs. 56 lakhs. Work on rice has mainly related to the trial of varieties suited to different conditions, distribution of seed of improved varieties, the publication of a summary of the results of manurial experiments on rice and so on. Of scientific interest are the conclusions that any rice variety can be made to flower within 60 days of sowing by 'light' treatment, that ordinary rice varieties can be made suitable for growing on salt lands by treating the seeds with a dilute solution of salt, and that scent in rice behaves as a simple recessive character. Work on the striga pest was continued but has led to no important practical result. A new scheme was sanctioned for research on the pulse crops—a step long overdue, we should think. A good deal of work has been done on the different oil seed crops, including coconuts and action has been taken to popularise cotton seed oil cake as a cattle feed. It is gratifying to note that one dozen mills have been started in the Punjab for the extraction of cotton seed oil and a large plant including an oil refinery has been started in Hyderabad (Sind).

In tobacco, the co-operative flue-curing scheme came to a close in the year and though the work was not all that was expected, it has demonstrated that high grade cigarette tobacco can be grown successfully in Nadiad, Jullundur, Sabour, Balaspur and Warangal. In the section of Horticulture, the cold storage schemes have yielded excellent results worthy of being adopted on a commercial scale, and so have the schemes on fruit preservation. We should like more attention being paid to the diseases and pests of fruit trees, as it is in this field that the cultivator looks for relief to scientific research. The prevalence of the codling moth in apples coming into India, is reported and it is a question for consideration if the imports of such fruits into free areas like Bangalore or the Nilgiris should not be prevented or controlled.

Schemes relating to Animal Husbandry alone and in combination with agriculture were twelve in number with an allotment of Rs. 25 lakhs. Among the schemes sanctioned in the year, two are of considerable interest both scientifically and practically, *viz*., one relating to the transmission of genetical factors in cattle, another to the artificial insemination of livestock. Several sheep-breeding schemes were in progress though with no outstanding results. A scheme for breeding Angora goats was sanctioned in the year. All feeding experiments have stressed the great value of berseem with meth (menthya) as the next best; groundnut oil cake has been found richest in digestible protein and deserves much wider use. Disease investigation has rightly received great attention; the spread of tuberculosis and Johne's disease is noted with alarm and the need for proper control measures has been emphasised. Very little progress has been made in milk recording and in pedigree registration. The question of the supply of milk from villages to towns was discussed in all its aspects and a number of appropriate recommendations have been made. There was a large increase in the number of stud bulls, to the extent of 30 per cent. Schemes for grassland improvement and mixed farming were sanctioned during the year, as well as several for the improvement of poultry and for pisciculture. We wish that the Council had stimulated the preparation of shark oil with some more direct financial and other aid than it appears to have done. Schemes on sugarcane and sugar research, agricultural marketing and cold-storage have all much useful work to show.

On the publication side the event of the year is the publication of *Indian Farming* which has been started as a popular monthly Journal and which keeps up a high level of excellence.

A. K. Y.

GUJARAT PREHISTORIC EXPEDITION

A PRESS COMMUNIQUE from the Director-General of Archæology in India states:—

The Archæological Department has recently organised an Expedition for the study of the prehistory of Gujarat with the co-operation of a number of institutions and scholars. Although the Department has hitherto organized systematic work on a large scale at sites belonging to the historic and prehistoric periods, particularly in Northern India, the occurrence and sequence of the earlier stone age cultures were not brought within the purview of its activities. Much interest has recently been taken in this subject, particularly since the British-American Expedition led by Dr. de Terra of the Yale University worked on the Ice Age and connected human cultures in North-West India and other areas. The Archæological Department has now in hand a Bibliography of South Indian prehistory, with a view to serve as the basis of future work. The pioneers of research in India's stone age

were geologists, particularly R. Bruce Foote, who, over 50 years ago, found palæolithic implements in Peninsular India so far north as Gujarat. One of the problems stated by Bruce Foote concerns the age of the palæolithic culture in the Sarbarmati valley and the gap or distance in time between that and the neolithic or later stone age culture. This has now been investigated by the Gujarat Prehistoric Expedition organized by the Archæological Survey.

The area chosen for this year's work is the Baroda State and parts of the Sarbarmati valley which lies in the Vijapur Taluka and of the Narmada valley in the Sankheda region have already been surveyed. On the Sarbarmati the examination of the river bed for a length of nearly 25 miles has yielded hundreds of specimens of quartzite implements, mostly found embedded in the pebble conglomerate formation. The age of these deposits is indicated by the fact that nearly 80 feet of alluvial deposits and blown loess overlies the original river bed forming the habitat of early stone age man. This roughly indicates the age as some 50,000 years. Besides these early stone age finds, a number of microliths or tiny stone implements left by man have been recovered from the top strata of the loess hills. In the valley of the Narmada and its tributary the Orsang besides microlithic finds, palæoliths have also been discovered for the first time.

Thanks to the ample facilities afforded by Sir V. T. Krishamachari, the Dewan of Baroda, it was possible for the Archæological Department to extend this expedition to Baroda State. Two scholars especially trained in prehistory have been engaged by the Department, and the Deccan College Post-Graduate and Research Institute, Poona, lent the services of its Professor of Ancient Indian History. The Baroda Archæological Department, the Gujarat Sahitya Sabha and the Gujarat Research Society have also co-operated. The results obtained so far have considerably advanced the scientific knowledge of early man in India, and it is hoped that if this enterprise is continued on a systematic basis the story of India's earliest inhabitants would be better known and a chapter of human endeavour in its earliest form unearthed from the fruitful banks of India's rivers.

CENTENARIES

Shrapnel, Henry (1761-1842)

HENRY SHRAPNEL, the inventor of the shell bearing his name, was born at Bradford-on-Avon 3 June, 1761. He received a commission as second lieutenant in the royal artillery in 1779. He saw service in Newfoundland, Gibraltar and West Indies. He became first assistant inspector of artillery in 1804, colonel in 1813 and major-general in 1819 and retired in 1825.

Between 1784 and 1804 he made many experiments at his own expense on hollow spherical projectiles filled with bullets. By 1803 his shell was adopted for service. This destructive shell has now come into universal use. In 1808 the Duke of Wellington testified to its remarkable value and recommended that the invention should not be made public but that Shrapnel should be given a suitable reward as compensation for being deprived of fame and honour by such a secrecy. He further said, in regard to the praise that should go to Shrapnel, "You may say anything you please, you cannot say too much". Sir George Wood who commanded the artillery brigade at Waterloo wrote in 1815 that had it not been for Shrapnel's shells, the battle of Waterloo could not have been won.

The Board of Ordnance did not, however, uphold the request of Shrapnel to be compensated for the expenditure he had incurred in the invention. In 1837 when Shrapnel was the guest of William IV, the king personally acknowledged his high sense of his services and was agreeable to confer a baronetcy on him. But the death of Shrapnel's son shortly thereafter led to the dropping of the proposal. Shrapnel himself died a disappointed man, at Southampton 13 March, 1842.

Courten, William (1642-1702)

WILLIAM COURTEN, a British naturalist, was born in London 28 March, 1642. While in his travels to Montpelier, he came across Sloane and this led to his interest in botany. After a good deal of foreign travel, he opened in 1684 his botanical museum in the Temple. It was estimated to cost 50,000 guineas. This went over to Sloane and ultimately became the nucleus of the famous Sloane collection of the British Museum.

Courten's name was immortalised by Robert Brown who founded the genus *Courtenia* upon a plant from Java.

Courten died at Kensington 29 March, 1702.

S. R. RANGANATHAN
University Library,
Madras.

SCIENCE NOTES AND NEWS

Solar Influences on Terrestrial Conditions.—The studies made at the Solar Physics Observatory, Kodaikanal, of the periodic phenomena connected with solar activity, such as, the number and dimensions of spots, prominences, bright and dark markings, show that the present solar cycle, which began in 1933, reached its maximum intensity in 1937, and remained at the maximum all through 1938. At the moment, the activity is on the down grade and may be expected to reach its minimum in 1943–44.

Some of the short-lived, sporadic phenomena studied are the eruptions which present a variety of appearances and effects. For example, on June 2, 1937, a very massive prominence with a base of 1,67,000 miles and a height of 85,000 miles, which had been stable for more than three days, was suddenly blown up presumably by an eruption. On several occasions eruptions on the sun were found to cause radio "fade-outs" and general dislocation of radio communications. Particularly, when vigorous eruptions in the neighbourhood of sunspots close to the central meridian were observed, magnetic and electric disturbances invariably occurred on the earth. A remarkable instance of such solar influences on terrestrial conditions was the great magnetic storm and auroral display of March 24, 1940, when a great eruption affected several hundred million square miles of the sun's visible surface.

Forest Research in India and Burma during 1940–41.—The first part of this annual publication (Manager of Publications, Delhi, Rs. 1-12) recently issued, records the work turned out during the year at the Forest Research Institute, Dehra Dun. It was inevitable that war supply problems should preponderate in the research programme for the year. The authorities responsible for the policy of the Institute decided that research should be the main preoccupation even during the war. During times of stress, it is not easy to resist the temptation of converting such institutions to mere supply units. The wisdom of the authorities in taking this major decision of policy could be seen in practically every page of the present publication wherein practical solutions of many problems ranging from army hutments to tent pegs, are intermingled with the results of "pure" research in "sylviculture" whose contribution to the development of Indian forest research would be substantial even in the post-war period.

This report of 161 pages consists of seven chapters; the first one gives very readable summaries of the several branches of the Institute, prefaced by a "General" summary. The following six chapters give more detailed accounts of the work in the sylvicultural, utilisation, entomology, chemistry and timber development branches. Not the least important amongst the contributions of the Forest Research Institute to the war effort is the provision of trained personnel for jobs requiring specialised training. During the year, 48 publications emanated from the Institute in addition to 26 papers in scientific journals. The total expenditure of the Institute was about 6½ lakhs of rupees.

Root-Inducing Substances.—The root-inducing activities of indole acetic acid, naphthalene acetic acid, phenylacetic acid and their esters have attracted the attention of both scientists and nurserymen, and large-scale experiments have been carried out to utilise these substances for clonal propagation of economic plants. The growth substances induce root formation when they are used in dilute solutions, and the effective concentration can only be determined by a series of tests. Lanolin, water and talc powder can be made use of as carriers.

In a recent work Hitchcock and Zimmerman (*Contr. Boyce Thompson Inst.*, 1940, **11**, 143) have shown the root-inducing properties of these substances when they are used in mixtures. A higher percentage of rooted cuttings and uniform rooting was manifested in cases of application with mixtures. Vitamin B_1 and ethylene functioned as activators for root formation when they were applied in combination with the growth substances. M. J. T.

Pupation of *Ephestia kuehniella* Zell.—Old prepupa, a high percentage of younger prepupæ, and a few old larvæ of *E. kuehniella*, can pupate at 6–9° C. (42·8–48·2°). The young prepupæ and old larvæ that are unable to pupate at this low temperature, develop into "permanent larvæ", living considerably longer than their pupating age-mates, without pupating. Larvæ kept for 2–8 months in this temperature are able to pupate if returned to room temperature. If, however, their heads, the source of the pupation harmone, are tied off, they become permanent larvæ, surviving as long as 2–3 months in the larval state. It is concluded that the formation of the pupation harmone is inhibited by exposure to low temperatures and there is some indication that the tissues can, perhaps, react to a harmone stimulus at low temperature (Caspari, *J. Expt. Zool.*, 1941, **86**).

The Indian Lac Cess Committee.—The annual report for the year ending 31st March 1941, records the activities of the Indian Lac Research Institute in India, the London Shellac Research Bureau and the Special Officer, Lac Inquiry and Co-operative Research.

A refreshing feature of the Committee's work is the co-operative research started in this country and in England. The Committee has made grants to Messrs. The Metropolitan-Vickers

Electrical Company, Ltd., and the India Moulding Company, Calcutta. We are also told that steps have already been taken to carry out co-operative research work on rubber-shellac combinations in India.

Special mention should be made of the exceedingly practical step taken by the Committee in sanctioning a sum of Rs. 2,000 for practical aid to be given in 1941-42 to manufacturers of lac in trying out experimentally improvements effected at the Indian Lac Research Institute in methods of manufacture and utilisation of lac. It is hoped that this praiseworthy step will soon result in the stabilisation and expansion of the old industries and in the creation of new ones.

Charcoal for Lorries and Buses.—An important leaflet relating to the production of charcoal, suitable for producer gas for lorries and buses, has recently been issued by the Forest Research Institute. Owing to the urgent need for conserving petrol, attention has centred on the possibility of converting a large number of lorries and buses into charcoal-gas vehicles. There are now some 37,000 such vehicles in British India and assuming that half of these are to be converted to run on charcoal gas, approximately 18,000 tons of charcoal per month will be required. India can produce suitable charcoal for the purpose; what is needed is organization especially in the spheres of supply, grading and distribution.

Any hard, close-textured wood makes good charcoal. The harder and closer-textured the wood is, the better the charcoal for producer gas, provided its ash content is low. *A few* of the suitable woods listed in the leaflet are:—Babul (*Acacia arabica*), axle-wood (*Anogeissus latifolia*), casuarina, anjan (*Hardwickia binata*) and the oaks (*Quercus* spp.). The charcoals produced from these woods have been tried on producer gas plants and found suitable. Leaflet No. 9 (published by the Forest Research Institute, Dehra Dun) gives specifications for producer-gas charcoal, and other information likely to be of use to charcoal manufacturers.

Locust Situation in Northern India.—In spite of the cold weather, locust swarms in the fortnight ending on December 20, 1941, were active in the western United Provinces, southern and western Punjab and eastern districts of Baluchistan. There was very little swarm activity in the permanent breeding areas, *viz.*, Rajputana, desert parts of Sind and coastal areas of Baluchistan. In the Punjab and the U.P., the conditions are ominous as they generally receive rain during spring when due to rise in temperature the over-wintering locusts are expected to breed if soil-moisture conditions become suitable.

American Technical Mission for India.—The announcement that an American Technical Mission is to visit India is of considerable interest. Until the summer of 1941 when the effect of the Lease-Lend legislation in the United States began to be felt in India, contacts between India and the United States had remained more or less normal. America was buying mica, manganese, and other raw materials from India, while India was buying from America motor vehicle chassis, machine tools, and other things required for the war effort, as well as a large range of ordinary merchandise the flow of which was naturally restricted by the dollar exchange position.

With the establishment of the Indian Purchasing Mission in the United States, the position has changed. India has had to state very fully her case f[illegible]
and after a study of the documents presented to them by Sir Shanmukham Chetty the American experts suggested that India might benefit considerably by the visit of a Technical Mission from America. This suggestion has been welcomed by the Government of India, the more so in that they are well aware that in America, as in the other Allied countries, experts are very fully occupied at the present time with war production. It is hoped that the Mission may be able to fill some of the gaps in India's munitions production.

The Government of the United Kingdom have been actively concerned with the development of India's resources for the supply of war requirements by implementing the recommendations of the Chatfield and Roger Mission reports and otherwise. They have expressed their appreciation of the initiative of the Government of the United States of America and their confidence that it will lead to valuable results in supplementing what has already been done.

Indian Central Jute Committee.—According to a press note dated 4th March 1942 issued by the Publicity Officer, the Indian Central Jute Committee, in furtherance of its policy of associating the Universities in research work on jute, has sanctioned a grant of Rs. 16,580 for 1942–43 to be distributed as follows:—

University of Calcutta:—Schemes for X-Ray Research on jute fibres by Prof. M. N. Saha—Rs. 5,060; Investigation on the chemical utilisation of jute and jute waste by Dr. B. C. Guha—Rs. 2,800; Bio-chemical investigations of the processes involved in the retting of jute by Dr. B. C. Guha—Rs. 2,300.

University of Dacca:—Scheme for impregnation of bleached fibre with suitable resins by Dr. J. K. Chowdhury—Rs. 3,300.

Presidency College:—Researches relating to the growth and development of jute fibre by Prof. B. C. Kundu—Rs. 3,120.

The total approximate financial liability of the Committee in connection with these schemes, spread over three years, is expected to be Rs. 46,980.

Research Scholarships and Fellowships in the University of Patna.—With a view to stimulate and intensify research, the University of Patna have provided Rs. 15,000 for the year 1941. In consideration of the present conditions, the Syndicate have felt the need of giving special encouragement for the prosecution of research in the pure and applied sciences. Under the new scheme which was drawn

by a Special Committee appointed for the purpose, the value of the research scholarships has been raised to Rs. 100 per month, ordinarily open to graduates of the Patna University. The University have also instituted Research Fellowships of the value of Rs. 150 per month, open to candidates who have secured the degree of PH.D., or M.D., or M.S., of the Patna University on the basis of their researches. These candidates are expected to devote the whole of their time to research and are not permitted to undertake any other kind of work.

The Syndicate has also come to the conclusion that "Research Scholarships may be awarded to suitable candidates of the University to work at institutions outside Patna, *e.g.*, Jamshedpur Research Institute, Indian Institute of Science at Bangalore, etc., and other similar places, where graduates of the Patna University may be admitted to work under eminent and distinguished scientists. The Vice-Chancellor has also been advised that the problems of research chosen should be of immediate value to the areas under the jurisdiction of the Patna University. It would be appreciated, that research in such subjects as mining, mineralogy and geology, are of supreme importance. But, as no scheme is ready whereby admission of Patna University graduates is assured to institutions where such researches can be carried on, the Syndicate has felt that for the time being, it is precluded from awarding scholarships for research at any such places. As soon, however, as such a scheme is worked out, it is proposed to award scholarship for research in those subjects."

Scientific and Industrial Research Board, Hyderabad.—The Second Meeting of the Board was held under the presidentship of the Hon. Nawab Sir Aqeel Jung Bahadur, on 27th December 1941, to consider the programme of researches recommended by the various research committees under the Board and to allocate funds. The Chairman of each committee explained the schemes of research proposed by his committee after which there was a full discussion regarding the relative importance and utility of different problems. A total grant of Rs. 21,500 for a period of one year was sanctioned by the Board for carrying out research work on certain problems recommended by the research committees. The grant was distributed among the various committees as follows:—

Vegetable Oil Utilization Committee—Rs. 2,500; Pharmaceutical and Drugs Committee—Rs. 4,000; Fuel Committee—Rs. 500; Fibre Research Committee—Rs. 2,000; Ceramic Research Committee—Rs. 4,000; Heavy Chemicals Committee—Rs. 5,000; Forest Products Utilization Committee—Rs. 1,000; Industrial Ferments Committee—Rs. 2,500.

Medical Degrees which are not Recognised in India.—The Medical Council of India have recommended to the Government of India that the recognition of medical degrees granted by certain Universities in Australia, South Africa, Ceylon, Canada, Hongcong and Malaya should be discontinued as these countries recognise Indian medical qualifications only when the qualifications are recognised by the General Medical Council in the United Kingdom. The Government of India have accepted the recommendation.

The withdrawal of recognition will affect only degrees to be granted after March 31, 1942.

The Medical Council is prepared to enter into negotiations for the mutual recognition of medical qualifications with countries which are willing to recognise Indian qualifications on the basis of direct reciprocity.

The Universities concerned are:—The University of Sydney. The University of Adelaide. The University of Capetown, The University of Witwaterstand. Johannesburg, the Ceylon Medical College, Nova Scotia Provincial Medical Board, Dalhousie University, The University of Hongkong, and the King Edward VII College of Medicine, Singapore.

Dr. N. Kesava Panikkar, M.A. (HONS.), D.SC., Empire Overseas Research Scholar of the Royal Commission for the Exhibition of 1851, has been appointed Professor of Zoology in H. H. The Maharaja's College of Science, Trivandrum. Dr. Panikkar is a distinguished graduate of the Madras University and a member of the staff of the Madras Christian College. He was awarded the Exhibition Scholarship in 1938 for research in Marine Biology. While in England, Dr. Panikkar was engaged in the study of the mechanism of physiological adaptation in animals. He has some 26 papers to his credit.

Information has been received that the Royal Society has provided a special grant for his researches at Travancore.

Calcutta University.—Dr. Bidhan Chandra Roy has been appointed Vice-Chancellor of the Calcutta University for a period of 2 years in succession to the Hon'ble Sir Azizul Haque who has been appointed High Commissioner for India in London.

Andhra University.—At the meeting of the Senate held on the 14th March, Sir C. R. Reddy was unanimously re-elected Vice-Chancellor of the University for a further period of three years. The election was uncontested. Sir C. R. Reddy possesses the unprecedented record of having been elected Vice-Chancellor for five terms.

SEISMOLOGICAL NOTES

During the month of February 1942, one moderate and two slight earthquake shocks were recorded by the Colaba seismographs as against three moderate, and six slight ones recorded during the same month in 1941. Details for February 1942, are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
February 1942		H.	M.	(Miles)		(Miles)	
16	Slight	23	39	5870	..	..	
21	Moderate	12	38	4230	..	..	
22	Slight	03	17	13.0	Lat. 27° N., Long. 92° E., in Assam	..	Reported to have been felt in parts of Bengal and Assam

MAGNETIC NOTES

February 1942, was magnetically more disturbed than the previous month. There were 12 *quiet* days, 12 days of *slight* disturbance and 4 of *moderate* disturbance during February 1942, as against 5 quiet days, 22 days of slight disturbance and one of moderate disturbance during February of last year. The day of largest disturbance during February 1942 was the 23rd and the quietest day was the 18th.

The characters of individual days were as follows:

Quiet days	Disturbed days	
	Slight	Moderate
3, 4, 7-9, 11-13, 17, 18, 21, 26.	1, 2, 10, 14-16, 19, 20, 22, 24, 25, 27.	5, 6, 23, 28.

No magnetic storms were recorded during the month of February this year as also last year. The mean character figure of the month is 0·71 as against 0·86 for February of last year.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

Planets during April 1942.—Venus will be a conspicuously bright object visible in the eastern elongation from the Sun (46° 19'). Mercury: On April 14, the planet reaches greatest western elongation from the Sun (46° 19'). Mercury likewise will be a morning star in the first half of April, but will be too close to the Sun to be well seen during the month; it is in superior conjunction on April 20 and passes afterwards into the evening sky. The four major planets Mars, Jupiter, Saturn and Uranus continue to be near each other in the constellation Taurus and can still be seen in the western sky for a short while after sunset. In their eastward motion among the stars Mars will overtake Jupiter on April 4 when there will be a close conjunction of the two planets. Similarly Saturn overtakes Uranus on April 28 and as the objects will be fairly close to each other at the time (Saturn about a degree and a half to the south of Uranus) it will not be difficult to locate the latter planet with some slight optical aid.

T. P. B.

ANNOUNCEMENTS

The Indian Geographical Association.—At the annual meeting of the Madras Geographical Association held at Madras on March 7, a resolution to the effect that the name of the Association should be changed to the Indian Geographical Association was adopted. The *Journal of the Madras Geographical Association* will henceforth be called the *Indian Geographical Journal*. The headquarters of the Association will continue to be at Madras and provision has been made for starting local branches all over India.

A Fresh Cycle of Desert Locust in India (*Curr. Sci.*, 1941, 10, 479).—We have been informed that the map illustrating the article has been adapted with modifications from Uvarov (*Imp. Bur. Ent.*, London, 1928, pp. 252-55). We regret that this was not mentioned in the article.

* * *

We acknowledge with thanks receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 90, Nos. 4601-4603.

"Journal of Agricultural Research," Vol. 63, Nos. 7-8 and 11.

"Biochemical Journal," Vol. 35, Nos. 8-9.

"Contributions from Boyce Thompson Institute," Vol. 12, No. 3.

"Journal of Chemical Physics," Vol. 9, Nos. 11 and 12.

"Journal of the Indian Chemical Society," Vol. 18, No. 11.

"Chemical Products," Vol. 5, Nos. 1-2.

"Indian Forester," Vol. 68, No. 3.

"Transactions of the Faraday Society," Vol. 37, Part 12.

"Indian Farming," Vol. 3, No. 2.

"Indian Central Jute Committee (Bulletin)," Vol. 4, No. 11.

"Review of Applied Mycology," Vol. 20, Pts. 1 and 2.

"Journal of Nutrition," Vol. 22, Nos. 5 and 6.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

February 1942. SECTION A.—SIR C. V. RAMAN: *New concepts of the solid state.* Presidential address to the Indian Academy of Sciences, 1941. R. P. SHINTRE: *Studies in educational statistics. Part IV. A criterion of examination efficiency by the method of adjusted plot yields.* K. NEELAKANTAM AND L. RAMACHANDRA ROW: *Fluorescence reactions with boric acid and o-hydroxy-carbonyl compounds, and their application in analytical chemistry.* VIKRAM SARABHAI: *The time distribution of cosmic rays.* At least upto the small time intervals 1/50 sec. reached in the experiment, the arrivals of cosmic rays follow a law to be expected from time randomness; and their behaviour is therefore similar to that shown by radiations from radioactive sources. H. J. BHABHA AND D. BASU: *The theory of particles in spin half and the Compton effect.* The formula for the scattering of radiation by a free electron on the hole theory is calculated. The hole theory is in definite disagreement with experiments on scattering although it is in at least qualitative agreement with nature in describing the existence of the position and the process of pair creation, and is the only form in which the Dirac theory is logically tenable. L. RAMACHANDRA ROW AND T. R. SESHADRI: *Flavylium salts containing pyrone rings.* P. SURYAPRAKASA RAO: *Occurrence of luteolin in the flowers of* Chrysanthemum indicum. S. S. PILLAI: *On numbers of the form* $2^a \cdot 3^b$ *(I).* S. S. PILLAI AND ALLEYAMMA GEORGE: *On numbers of the form* $2^a \cdot 3^b$ *(II).* T. K. KRISHNASWAMY: *Estimation of cystine by nitroprusside.* The method described has the advantage of simplicity over the Sullivan reaction, and is more specific than the Folin and Marenzi uric acid reagent.

SECTION B.—SIR C. V. RAMAN: *New concepts of the solid state.* T. S. RAGHAVAN AND V. K. SRINIVASAN: *A contribution to the life-history of* Vahlia viscosa, *Roxb., and* Vahlia oldenlandioides, *Roxb.* N. K. IYENGAR: *Trypsin-kinase in blood.* N. K. IYENGAR: *Anti-tryptic components of blood.* N. K. IYENGAR: *Prothrombin and plasma trypsin.*

Indian Chemical Society: (*Journal*)

November 1941.—N. N. GODBOLE, B. G. GUNDE AND P. D. SRIVASTAVA: *The seed fat of* Buchanania latifolia. T. L. RAMA CHAR: *Studies on the photochemical activity of mixtures of vanadic acid and tartaric acid. Part II. Photocatalysis by colloidal micelle obtained by the reduction of vanadic and tartaric acid.* Induced optical activity by circularly polarised light. PRODOSH CHANDRA RAYCHOUDHURY: *Normal aluminium chromate.* PRODOSH CHANDRA RAYCHOUDHURY: *Periodates of tervalent metals.* R. P. DAROGA: *The colorimetric (p-dimethylaminobenzaldehyde-sulphuric acid) method for determining small quantities of atropine.* P. L. KAPUR AND BADAR-UD-DIN: *Estimation of copper in presence of iron.* R. K. BAHL, SURJIT SINGH AND NARINDRA K. BALI: *Estimation of iodine in periodates.* S. SIDDIQUI AND Z. AHMAD: *A note on the new formula for chaksine.* D. P. CHATTERJEE: *A note on the separation of silicon and tin in tin-silica mixture welding brasses and silicon brasses by alkali sulphate.*

Tin and Its Uses:

October 1941, No. 11.—"The current issue of *Tin and Its Uses*, the Quarterly Review of the Tin Research Institute, examines the various trends in tin consumption in the United States in the present emergency. The relative merits of tin and the suggested alternatives are discussed, and it is concluded that major changes in the use of tin would involve substantial expenditure on research and new equipment, and are likely to be deferred so long as the supply position permits. American stocks and deliveries of tin are particularly favourable at present, and if the analogy of British experience is followed, war production will still further stimulate, rather than diminish, the consumption of tin.

"Progress in the Institute's programme of industrial research is reported in this issue. The causes of difficulty in tinning certain batches of mild steel are explained, and various simple means of rectification are described. It is emphasised that there need be no steels difficult to tin provided that suitable precautions are taken in manufacture, and that buyers should be able to avoid troubles by specifying steel of "good tinning quality".

"The Institute has carried out tests on alternatives for palm oil and tallow in the hot-tinning process. Certain oils have been compounded which have excellent stability at high temperatures and considerable freedom from fuming and from fire hazard. Trials of these oils in industrial plants have been highly successful.

"Other articles in this issue include a description of an Australian test of the Institute's process for protecting tinplate against sulphur-staining by foodstuffs; a review of the use of tin in printing metals: an account of further improvements in tinfoil; and a pictorial record of special uses of canned foods in war-time England."

ERRATUM

Vol. 11, No. 2, February 1942, Page 81, in the table pertaining to Magnetic Notes: Under Quiet days, figure 18 has been omitted, and under moderate days for 2 *read* 17.

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HEREDITY AND ENVIRONMENT IN HUMAN GENETICS*

BY

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HUMAN genetics has become a field in which the principles of genetics and cytology determined by experiments with plants and animals can be applied to an ever-increasing extent. We speak of animal and plant breeding as applied genetics, but the need of applying genetical principles to the reproduction of mankind is even more urgent than is the case with domesticated plants and animals. With the latter, selection of the best individuals as parents of the next generation is continually practised, and defective individuals are rigidly excluded from reproduction. Man has hitherto failed seriously, however, in applying to his own species the rules which he finds so necessary for the improvement or even the maintenance of his flocks and herds and his plant crops.

Any student of human genetics knows that large numbers of the same aberrations and abnormalities, both physical and mental (nervous), occur in mankind and in the higher mammals. These deleterious parallel mutations are carefully weeded out from the animals over which we have control, and among wild animals natural selection weeds them out. One of the outstanding discoveries of modern genetics is that all organisms produce such mutations, the majority of them deleterious in their effects and some of them even lethal. That they flourish in our own species is well attested by innumerable published pedigrees of almost every conceivable abnormality of body and mind—pedigrees extending often to five or six and sometimes even to ten or more generations in a single family. How is it possible to think of the improvement of civilized man while these weeds grow unchecked in the human garden? It is a little-considered fact that the matings of this generation determine in their entire hereditary make-up the qualities of all future generations.

Selective mating is a well-known fact, that is, that like tends to mate with like. This applies not only to stature (in some cases), but also to the blind, the deaf and the congenitally maimed. They tend to marry each other and so perpetuate the condition if it is due to inheritance, as it is in a large proportion of cases. At the other end of the scale, it is clear that various types of ability are inherited. Mathematical and musical ability are outstanding cases, but there are many others. Any student of genetics knows that if a defect such as feeble-mindedness is inherited, its normal counterpart is also inherited. A few psychologists still quaver at the acceptance of mental inheritance, but anyone who faces the facts squarely will be obliged to admit that, however you analyze the mind, mental differences are inherited as well as their physical basis in the brain and the central nervous system. A few examples of such inheritance will be referred to later.

But heredity does not work in a vacuum. Heredity and environment are like the two sides of a shield, the shield being the developing organism. An optimum environment is just as essential, but no more so, than a good heredity, if a satisfactory result is to be achieved. Nature has taken infinite pains to ensure that the early environment of the developing embryo will be uniform and that it will have complete protection. What it becomes will then depend largely on the genetic composition of the two germ cells that united to begin its development. Incredibly small differences are found to be inherited through a whole series of generations. Most of the differences we see in any gathering of people are determined mainly by heredity. A very unfavourable environment may inhibit the developmental potentialities of the

* A lecture given at Vassar College, Nov. 12, 1941.

organism, making the individual stunted and starved either in body or mind, and by an unsuitable environment he may be warped or distorted in his mental and physical processes. But the inheritance carried in his or her germ cells will not be changed by such treatment. Cases are on record of identical twins, developed from a single egg cell and having the same heredity, one of whom developed scoliasis (curvature of the spine). This induced condition would obviously not be inherited.

Heredity and environment have played their part in producing the various races of mankind as we know them. But the active part in the differentiation of races has no doubt been played by inherited (germinal) variations or mutations. The beginnings of racial differentiation are lost in paleontological obscurity and it is impossible to draw any sharp distinction between the so-called racial differences among modern men and specific differences such as that between Neanderthal man (*Homo neanderthalensis*) and *Homo sapiens*. The conventional habit of applying the latter specific name to all living races of mankind is probably not justified. This view, which I first expressed some years ago, is strengthened by the recent discovery that three different species of Cebus monkey are inter-fertile and will interbreed. Many anthropologists believe that Neanderthal man interbred with Cromagnon man (who supplanted him in Europe) and is therefore a part of our direct ancestry. At any rate, the criterion of intersterility as a mark of species (either present or past) as distinguished from races, no longer exists.

When we consider the main types of living man from a genetical point of view, some of the racial characters appear to be adaptive in nature while others probably have no adaptive value. Since it has been found that the nasal index (length : breadth) of peoples from Terra del Fuego to the Arctic coast of Canada correspond roughly with the degrees of North or South latitude in which they live, it appears that the very narrow nasal passages of the Eskimo are an adaptation to breathing cold air while the broad, flaring nostrils of the African negro are advantageous for breathing the warm, moist air of the tropics. The thick lips and dark, glandular skin of the negro are probably also adaptations to the high temperature and intense sunlight of the tropics. On the other hand, the kinky hair, which is equally characteristic of the negro type, is probably not adaptive. The straight hair of the American Indian or the wavy hair of the Australian aborigine would do as well in a tropical environment. That this racial character of kinky hair has arisen as a single mutation appears to be indicated by the fact that it has appeared independently as a rare mutation inherited through several generations in families in Norway, England and Holland. The kinky or woolly condition is dominant in inheritance in these families, just as the kinky hair of the negro is dominant in crosses with other races.

It is now recognized that not only physical but physiological differences exist between the human races. We have already referred to adaptations of the negro to the tropics and the Eskimo to Arctic conditions. Negroes are also believed to be immune to the virus of yellow fever, although hypersusceptible to the bacillus of tuberculosis. Japanese similarly appear to be immune to scarlet fever and the Chinese relatively immune to the tetanus bacillus. Measles is a mild virus disease among Caucasians but very severe for North American Indians and Melanesians. Malaysians are more susceptible to beri-beri (lack of vitamin B_1) than other races. Some of these resistances have probably been gradually acquired by the selection resulting from exposure of successive generations to the disease organism over a long period. In other cases the racial resistance appears to be more of the nature of a happy chance. Experimental studies of resistance and susceptibility to many parasitic diseases in plants and animals lead to similar points of view. These differences persist even with different races living under essentially the same conditions. Thus in New York City, statistics show that Russians, Poles and Jews are much more resistant to tuberculosis than are the Irish.

These inherited differences in resistance to particular diseases apply not only to races but also to the individuals within a race. Thus some 50% of human beings and 30% of horses show natural immunity to diphtheria. Similarly, experiments showed that in Berlin in 1907 nearly 100% of the house mice were susceptible to tumour inoculation. The same was true of about 24% of the mice in Hamburg while

practically none of the mice in Oslo were susceptible. There are similar great variations in the susceptibility of pigs and rabbits to enteritis. Many cattle are immune to *Bacillus abortus* and over 50% of rats are immune to plague. Many of these resistances are probably Mendelian in their inheritance. Such cases of inherited resistance to particular micro-organisms could be largely multiplied from the experimental literature. They emphasize the importance of the inherited constitution of the individual, whereas medical attention has too frequently been concentrated entirely on the attacking bacillus.

Statistics show also that resistance varies at different stages of development. For instance, the mortality rate from diphtheria and scarlatina is at first higher for males and later becomes higher for females. It has been shown that constitutional factors also play an important part in the structure of the teeth, the intestines and the eye. The fact that the mortality rates for various diseases differ in males and females again shows the effect of genetic constitution.

From time to time epidemics of infantile paralysis (poliomyelitis) occur, the origins of which cannot be traced. In a study of this condition in 222 families in which a case of infantile paralysis had occurred, 35% of the other children had minor illnesses at about the same time, whereas in families without infantile paralysis, only 9% of the children were ill. A part at least of this higher incidence of illness was due to an abortive form of infantile paralysis lasting from a few hours of indisposition to several days of illness. Nasal washings from such cases when inoculated into monkeys actually produced the typical symptoms of poliomyelitis. It is therefore clear that many children are highly resistant to the disease. They may be temporary carriers of the virus and yet have only minor symptoms. Quite possibly others who harbour the virus for a longer period without symptoms may be the infective source of the epidemic.

Other studies have shown that constitution of the child is more important than the virus in the development of poliomyelitis. From an anthropometric study of susceptible children it is found that the susceptible type is large and plump, with a broad, round face and frequently wide-spaced dentition. Those in whom the disease was most severe and often fatal were a more delicate, brunette type with high colouring of lips and cheeks and crowded teeth. The fathers and mothers also showed certain characteristic features. Anthropometric data from 57 male and 52 female affected children showed that the interpupillary distance was great, the hands short and broad, the pelvis wide in comparison to the shoulders. There were also certain mongoloid tendencies, suggesting thyroid deficiency. While the matter requires further investigation, it seems clear that susceptible children are distinguishable by a whole series of constitutional differences from other children.

Racial differences, however, are not confined to differences in susceptibility to attack by micro-organisms. Organic diseases which are a direct inheritance vary markedly in their incidence from race to race. Thus amaurotic idiocy is a metabolic and mental derangement, genetically determined and lethal in its effect, which appears to be largely or wholly confined to Jews. In Italy there is a disease, known as favism, caused by eating the broad bean (*Vicia faba*) or inhaling the pollen of this plant. In Sardinia there are thousands of cases every year. It also occurs in Greece and North Africa and occasionally in people of Mediterranean ancestry living in the United States. But it appears to be confined to peoples of the Mediterranean race and not to occur in more Northern countries where the broad bean is also commonly eaten. This is an allergic disease affecting the red blood cells, and it was recognized as early as the 5th century B.C.

Sicklemia is a non-pathological condition of the red blood corpuscles in which they are sickle-shaped, with long, spine-like ends. It is inherited as a simple Mendelian dominant. In a small proportion of cases the affected red cells are attacked and destroyed by cells of the spleen, causing anæmia. This condition is accompanied by atrophy of the spleen and disappearance of the malpighian corpuscles. Some 7% of negroes have these sickle-shaped cells in their blood. The condition was formerly believed to be confined to negroes but has also been found in people of Greek and Italian descent. So it may prove to be characteristic of the Mediterranean as well as the negro race. The medical literature

also contains reports of several white families in which many of the red corpuscles were elliptical or oval in shape. This condition is inherited and is not accompanied by any ill effects, so it is only discovered when the blood is examined for some other purpose. Its frequency in the population is unknown, but it is probably rare, because many people now have their blood examined in hospitals. This is an example of the many slight abnormalities which are inherited but do not reduce the efficiency of the organism to any appreciable extent.

Levit has developed a large Medico-Genetical Institute in Moscow, where human genetics was being studied by a medical and genetical staff on a larger scale than in any other country. The fact that Russian families are large is also an aid in such investigations. More than 800 pairs of twins were studied medically to obtain as full an understanding as possible of their genetical (constitutional) make-up and development. Formulæ have been developed for the more accurate determination of the parts played by heredity and environment in the various stages of ontogeny. In this country, Newman and others have made extensive studies of twins, including pairs of identical twins (monozygotic, derived from the fertilization of a single egg cell) reared apart from an early age. These cases, which are almost as satisfactory material as an actual experiment, show that the remarkable physical resemblance of identical twins persists, even when they are reared under quite different social and climatic conditions. Even the finger print patterns are remarkably similar and only the minutiæ of these patterns, which make every human being unique, are beyond the limits of hereditary determination. Corresponding with these on the mental side are the differences which appear in the personalities and intelligence of the twins reared under different conditions of life. It appears, as might be expected, that the city dweller has an acquired urbanity which the twin brought up in the country does not possess. Certain emotional differences also appear. As regards intelligence, while the I.Q., as measured by the ordinary tests, is somewhat higher in the twin with the better education, yet the difference produced in this way is generally not large.

The detailed study and comparison of twins thus remains one of the most useful methods for investigating the relative effects of nature and nurture. Levit and his colleagues have shown in this way the important role of heredity in connection with the time of teething, sitting up and walking and in connection with such features as susceptibility to scarlet fever in children. Weight at birth was found to be practically unconnected with the genetic composition of the child. By comparison of children and adults, the effect of heredity on blood pressure and pulse rate was found to be very strong. As regards the sinus system and its conformation, various parts were found to differ greatly in hereditary determination. In a Jewish family in Western Germany a pedigree of very acute sinus trouble has been studied. The condition was inherited as a simple Mendelian dominant character, 17 cases occurring in a pedigree of three generations. By the use of the electrocardiogram for identical twins, Levit discovered a relation between the size of the heart and the "T"-wave on the electrocardiogram which is obscured by other factors in the general population. Thus even the detailed relation of physiological activities to morphological factors can be discovered. Identical twins were also treated differently and the results compared. Thus when one member of rachitic twins was treated with ultra-violet rays his immediate improvement was clear, but some months later the untreated twin was found to be superior in general health and resistance to disease.

From these and many other results, Levit emphasizes the fact that the roles of heredity and environment do not form a constant ratio in the growing organism, not even in relation to any one trait. These roles vary with age from infancy to senility. They vary also with the genetic and especially the environmental conditions. The extensive twin study results are classified according to the age of the twins and also according to their living conditions and the result is a more intimate analysis of environmental effects in some respects than has previously been attempted. Thus the most refined techniques of medicine, biology and statistics are being applied to a detailed and very practical solution of the nature-nurture problem. Such studies serve to emphasize that the human body is an almost infinitely complex moving equilibrium of organ systems from birth to death.

There is another aspect of the nature-nurture problem which is of great interest to anthropologists and psychologists. In a book which is soon to appear,* will be published an account of two native jungle children rescued from a wolf's den in India some years ago. They ate raw meat, drank like wolves, ran on all-fours, were active at night and had no language. Over a period of several years the diary records their reactions after they were brought to an orphanage. The elder girl survived several years and learned, after continual massaging, to stand and walk erect,—a matter at first of the greatest difficulty. She finally acquired many of the habits of civilization, such as the wearing of clothing, and gradually learned to speak, picking up a vocabulary of 30 or 40 words. Such records show how many of our civilized habits and customs are of the nature of conditioned reflexes, learned in babyhood from contact with our parents. The brain of these wolf children had not been permanently impaired, but its human development was inhibited by these early contacts with animals. A new set of reflexes and reactions had to be learned, including that of speech in place of the wolf's howl.

Blindness is a condition which of course may arise from an accident. But a large proportion of the cases of blindness are due to inheritance, even including many in which the condition is not congenital. Recent statistics show that in the United States the proportion of blind persons who have blind relatives or blind parents is, in the aggregate, 33·3%, while the proportion of blind individuals with blind brothers and sisters is 71·2%. Dr. Loeb, in an earlier study, found that in 1,204 families in which hereditary blindness is recorded there were 4,155 children, of whom 2,523 (60·8%) were born blind. More recent estimates conclude that 10-15% or more of all blindness is due to heredity, the frequency of blindness being about 1 in 1,000 in this country. This frequency estimate is evidently too low, however, since in 1932 there were 14,400 blind children in the United States under 20 years of age. 50,000 others were partially blind and some of them would develop total blindness later. Waardenburg lists more than 120 types of hereditary ocular variation, many of which cause blindness. Among the latter is glaucoma, and there are many pedigree of its inheritance in the literature. Sometimes it appears early and sometimes only in old age. The condition is one of hydrostatic tension within the eyeball, resulting from closure of the canal of schlemm, which may take place from various causes, hereditary or otherwise; or the intra-ocular tension may be set up by rigidity of the scleral coat or by effects on certain nerves or vasomotor centres. In certain families it is associated with gout, and various authors find that dark eyes are more predisposed to glaucoma than light eyes. These are probably matters of genetic linkage between otherwise unrelated conditions.

In a well-known family in Virginia, 18 cases of glaucoma developed in five generations. The original male ancestor married twice. The descendants by his first wife developed a high frequency of glaucoma, while those descended from the second wife were all free from this condition and included some of the leading men in American history. This type of glaucoma appears in the second or third decade and rapidly leads to blindness.

Deafness is another widespread condition which is often of hereditary origin. When only one ear is affected the deafness is likely to be of exogenous origin. The two main types of hereditary deafness are (1) deaf-mutism, in which the individual is congenitably without hearing and therefore unable to learn speech; and (2) otosclerosis, which usually comes on gradually in middle age, due to ankylosis of the stapes bone in the middle ear. Otosclerosis is inherited as a simple Mendelian recessive character. This means that two normal parents, if they both carry this gene, will have children one in four of whom may be expected to develop deafness in middle-age. The evidence indicates that hereditary deaf-mutism is produced by two genes, one of which controls the development of the ectodermal part of the cochlea, while the other controls the auditory nerve and its ganglion. Probably the development of the middle and outer ear is controlled by an independent pair of factors.

An exceedingly rare cause of deafness is the development of bilateral tumors on the auditory nerve. This produces a gradual onset of deafness and an unsteady gait. As

* Gesell Arnold, *Wolf Child and Human Child.* (Harper Brothers), 1941.

the tumors grow the optic nerve may also be affected, ultimately causing blindness. In an extensive pedigree with many affected individuals the inheritance is dominant. It also shows what is called "anticipation", i.e., the age of onset in the second generation was 72 years, while in the three succeeding generations the average ages of onset were respectively 64, 41 and 28 years.

Statistics show that when the deaf marry the deaf, one-third of these unions produce deaf children. There is no present way of distinguishing the hereditary from acquired forms of deafness, except that evidence of inheritance may be obtained from the ancestry. Unilateral deafness is practically always due to extraneous causes. Snyder and his associates in Ohio studied 31 families in which both parents were deaf. Their children numbered 89, of whom 63 (70·8%) were deaf. The only danger from cousin marriages lies in the possibility that both may have inherited the gene for the same recessive abnormality. Deafness is such a serious handicap that it seems clear that persons afflicted with hereditary deafness should not have children. The tendency for the deaf to intermarry is so strong that Alexander Graham Bell in 1884 wrote a memoir "Upon the formation of a deaf variety of the human race", directing attention to this danger.

Microphthalmia is an inherited condition in which the eyeball is so small that the individual has weak eyesight or may be blind. In one unique pedigree this condition is inherited as a recessive sex-linked character, i.e., it appears only in males but is transmitted by all their (normal) daughters. This is because the gene is in the X-chromosome and follows the zigzag course of that chromosome from male to female and from female to male in successive generations. Females, having also a normal X, do not develop the condition but transmit it to half their sons. In this pedigree of six generations, the microphthalmia is associated with mental deficiency in some individuals, while others are above average intelligence. As this association is also found in other pedigrees, these two conditions are probably both produced by a single gene, the microphthalmia itself being a very variable condition, like the end-results of an infective process in the eye. Fraser Roberts suggests that, since all those in this pedigree who are free from blindness are also free from mental defect, the mental defect must arise through extraneous influences at a critical stage in embryonic development which for genetic reasons, is abnormally sensitive.

Another condition which illustrates the pleiotropic or multiple effects of a single gene is known as acrocephalosyntactyly. Mohr describes such a family from a remote section of Norway. The father and five of the nine children showed the same conditions—syndactyly (webbing of certain fingers), a somewhat egg-shaped head with bulging forehead and underdeveloped occipital region, and intelligence somewhat below that of normal members of the family. In the inherited condition known as oxycephaly only the skull changes are present, without the associated abnormalities in the fingers.

Many families have been recorded in which the bones are so fragile that they are broken many times during infancy and childhood. In one such family the affected members are of short stature but have very long arms and legs. This is inherited as a dominant condition. In other families the condition of fragile bones is accompanied by blue sclerotics (due to the thinness or translucency of the white coating of the eyeball). A third condition associated with these two is otosclerosis. These three abnormalities, although one affects the bones, another the eye and a third the ear, are so commonly associated that they are probably all the effects of one gene. In those families where the effects on the eye or ear are suppressed this is probably due to some other feature present in the genetic constitution, or to the presence of modifying genes.

There are other pedigrees of anomalies which indicate that three or four genes are closely linked in the same chromosome. For example, anonychia (absence or defect of finger nails) may be closely associated with defect or absence of the patella and with luxation of the head of the radius. All three may be found together in certain pedigrees, in others the radius will be normal, while in still other families only the radius will be affected. These defects are very rare and are probably due to three separate genes which are so close together in a chromosome that they rarely or never cross-over, while the first two are in such intimate contact that they perhaps mutate

together. A fourth gene, for crooked little finger (camptodactyly), is associated with these three in some families. It is probably in the same chromosome but less closely linked.

A more complicated case is that of the Lawrence-Moon-Biedl syndrome, in which the cardinal symptoms are mental retardation, obesity, hypogenitalism, degeneration of the retina and polydactyly. After careful examination, no casual lesions are found either in the brain or the endocrine glands. These conditions have been regarded as the pleiotropic effects of a single recessive gene; but the pedigrees show that there is a preponderance of affected males and that the number of affected offspring is in excess of one-fourth in affected families. Dr. Madge Macklin has offered an explanation from a study of all the cases in the medical literature. She concludes that two factors are necessary for the production of this syndrome: (1) a dominant autosomal gene, (2) a recessive sex-linked gene.

Where the complicated effects of a gene involve more than one organ system it has sometimes been suggested that one germ layer, such as the ectoderm or the messoderm, has been involved. From a study of the creeper fowl, which shows many abnormalities from a single gene in the heterozygous condition which is lethal in the homozygous condition, Landauer concludes that the gene influences embryonic differentiation by producing a general retardation of growth. Thereby is determined a syndrome. Individual variations in the time and rate at which different embryonic organs appear will lead to frequent dissociation of the characters in the syndrome, but the gene will produce its effects by changes in the developmental pattern of the whole embryo. This type of explanation probably applies to many genes producing the more monstrous effects.

Another feature of the study of human heredity is that the same condition may be produced in one case by purely extraneous causes and in another by inheritance. The only way to distinguish them is by a study of the ancestors and collateral relations. Thus rickets is well known as a condition of children produced by lack of sunlight and vitamin D. But in certain cases where there has been no diet deficiency the same symptoms seem to have resulted from osseous dystrophy which was genetically determined. Hollow chest, also known as cobbler's breast, has long been supposed to be a result of the cobbler bending over his last. But it has recently been shown that this depression of the sternum is inherited in certain families as a simple dominant, and it is questionable whether it is an occupational disease at all.

To take an example of another kind, it is generally supposed that ingrowing toenails are the result of wearing tight shoes. I have no doubt that they are produced in this way sometimes, yet it is clear that the tendency to grow in will be greater if the nails show a strong lateral curvature. If the conditions were due solely to tight shoes, we might expect it to be more frequent in women than men, yet it is actually more frequent in men. In a recent case (*Lancet*, 1941, II: 410), a soldier who had been wearing army boots for 2½ years became ill and spent 14 months in hospital. During this time, in the absence of shoes, he developed an ingrowing nail which required attention. His nails were found to show an exceptional degree of lateral curvature. So even an ingrowing toenail has its inheritance element, which is by no means easy to disentangle from environmental effect.

Even the same symptoms may be due to different genetic causes. Thus hæmophilia is a condition in which the blood fails to clot, so that a slight wound causes a long period of bleeding. This is well known to be inherited as a sex-linked character. A rare condition has been described in a Russian family which shows the same symptoms of extreme abnormal bleeding, but this is caused by weakness of the capillary walls, the blood itself being normal, and it is not sex-linked in inheritance.

It seems that in many cases the genetic basis of an inherited peculiarity is quite different from what at first appears. Thus encysted tumors of the scalp are inherited, but the cause of their formation is probably an abnormally narrow duct to the sebaceous glands. Some of the inherited mental deficiencies have a biochemical basis. One form of oligophrenia (mental defect) is the result of failure to oxidize phenylpyruvic acid. It is inherited as a simple recessive condition. Albinism is biochemically related to this condition. Amaurotic idiocy (Tay-Sachs's disease) results from failure to oxidize the lipoid sphyngomyelin. Thus it is clear that even our mental condition has a biochemical basis.

Another peculiar inherited condition of

the nervous system probably has a biochemical basis. Several families are known in which excitement, a carbohydrate meal, cold or other causes will produce a temporary and more or less complete paralysis of the nervous system without loss of consciousness. The individual is helpless and speechless for a short time. Over 150 such cases have been reported from many parts of the world, and it is shown to be inherited in several families. It is known as temporary paralysis. The condition may come on periodically or under stress and it can be produced by excessive doses of desoxycorticosterone in the treatment of Addison's disease.

This condition is remarkably similar to that found in a breed of goats in Tennessee and Texas. When frightened, these goats become rigid so they can be pushed over and lie motionless for a short time before they recover. I have likened this condition to the death-feigning instinct in insects. It probably represents an essentially parallel mutation in these three groups of the animal kingdom. Somewhat similar is a white Vienna strain of rabbits which is spontaneously epileptic. By an injection of cardiazol, an epileptic seizure can be produced in animals or in man. It appears that a smaller dose will produce a fit in an inherited epileptic than in a non-inherited epileptic or in a non-epileptic, and so the method may be of diagnostic value.

Premature whitening of the hair is well known to be inherited in families. The gene in this case may in some way produce a lack of para-amino-benzoic acid, for it has been found that graying hair may become darkened by taking small doses of this substance. The relation of insulin to diabetes is too well known to need discussion here. But it may be pointed out that if this important medical discovery and the use to which it is put results in more diabetics passing on their inherited defect to the next generation, then the last state, from a racial point of view, is worse than the first.

An important study was made in Holland of the relation between physical resemblance and mental similarity. The thick-set eurosomics were found to be quiet, level-headed, giving a thoughtful impression, with relatively low temperature, slow pulse-rate and slow respiration. Slender leptosomics were psychologically more irritable and emotional. They tend to speak, walk and write with some haste, agitation and uncertainty. Their temperature is high, pulse and respiration rapid. Numerous psychograms were collected from parents and children. It was found that children who have a greater physical resemblance to one parent will also show greater mental similarity to that parent. No doubt many parents have made general observations of this sort on their own children. From a study of nearly 1,000 parents and nearly 2,000 children, it was concluded that the similarity between parent and child in activity, emotionality and in primary and secondary functions was greater when they physically resemble each other than when they do not. They also show greater similarity in intellectual performance, memory, etc. Physical resemblance was accompanied by similarity of all mental functions. While it is difficult to distinguish heredity from the effects of education, it was concluded that heredity far exceeds education in character formation and that the inheritance of moral qualities is greater than that of intellectual ones.

Finally, in connection with the nature and nurture problem I might point out how intimately we are all affected by the weather, and still more by climate. In a recent study of disease localization in the U.S. it was shown that meteorological conditions produce stimulation, overstimulation, fatigue and death, with effects on every shade of organ-function and disfunction, in every physical, psychical, economic and social sphere. We live at the bottom of an ocean of air and the normal individual is constantly reacting to his meteorological environment by a chemical and endocrine rhythm. Changes in barometric pressure, temperature and humidity may help or aggravate headaches, epilepsy, asthma, arthritis, gastric ulcer, neuroses, glaucoma, focal infections, urticaria and other conditions.

When we study any one inherited condition we try to find its least common denominator, to separate the specific effect of a particular gene from the rest of the genetic make-up or constitution and from the disturbing effects of a varying environment. Heredity is the solid residuum which persists from generation to generation, no matter under what climate or conditions we live.

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